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Geographical Science and Social Philosophy

V. C. FINCH

It is not uncommon for addresses on this occasion to be concerned with surveys of the content, methods and objectives of American geography. Happily this tendency has been interrupted by an occasional paper which has presented conclusions from a lifetime of special work. It is therefore at the risk of continuing a methodological tradition which may be unfortunate that I venture to state some thoughts which seem to me to need addition to the general body of geographical philosophy. Perhaps the assertion of Strabo that "the science of geography is, quite as much as any other, a concern of the philosopher," may serve as justification for another paper on this theme. If so, then my defense may be borrowed from the same authority, for he says "If I too undertake to write upon a subject treated by many others before me, I should not be reproached therefor unless I prove to have discussed the subject in every respect as have my predecessors."

The fact that methodological papers in geography have little in common except their purpose cannot have escaped attention. This may not be taken as an indication of the instability of the factual matter of geography; that does change, but not so fast. It is not geography but our thinking about it that seems to be driven into frequent reorientations. Disagreement with ancient points of view and even with those papers of several years past would, however, make no occasion for a reconsideration of geographical philosophy now. Their contents have been thought through, their methods have been tried by the lapse of time, and, insofar as they need answer, they have been answered. It is rather that in recent months there have appeared

several articles on geographic method and philosophy¹ or on trends of geographic thought,² each of which with great plausibility attempts to show that geography is moving or should be moving in a somewhat different direction. Publications in that vein beget their own kind. Back of the current papers above mentioned lies a group of substantial and well-known volumes³ which in recent years have painted, with the detail permissible on a larger canvas, views of the field of geography. That the several paintings of the same field made from different viewpoints should have something in common is as inevitable as it is desirable. That the details of foreground should differ is also no matter for surprise. Yet there exist between these views, large and small, basic differences of a kind and size one would hardly anticipate in the writings of equally qualified scientists in other fields, even those in the social sciences. Is this not more than merely an interesting fact? Does so great a divergence of thought mean that the aims and objectives of geography are constantly subjected to a healthy and beneficial searching and reevaluation, while those of other fields, especially the natural sciences, are more commonly taken for granted? Or, does it mean that geographers are constantly wasting effort in attempts to justify their procedures according to some standard set by an inexorable logic, while they might better be engaged in the collection and comparison of data according to any sane plan, regardless of logic? Does constant reexamination mean, for the rising school of geographical thought in America, a surer touch in geographic writing? Obviously that is one of the purposes behind this methodological searching. Some there will always be, of course, who will follow "arid classification" and "speak the patterned jargon of the day." But among the young geographers there are some who are troubled by the cross purposes and shifting of viewpoint evident in the writings of mature men in the field. Has uncertainty already led geographers to develop an acute self-consciousness in the face of conflicting views upon method and

¹ Leighly, John, "Some Comments on Contemporary Geographic Method," these *Annals*, Vol. XXVII, 1937, pp. 125-141.

Crowe, P. R., "On Progress in Geography," *Scot. Geog. Mag.*, Vol. 54, 1938, pp. 1-19.

² Pfeiffer, G., "Entwicklungstendenzen in Theorie und Methode der Regionalen Geographie in den Vereinigten Staaten nach dem Kriege," *Zeits. der Gesell. für Erdk. zu Berlin*, Jahrg. 1938, Nr. 3./4. Also a series by nine authors who discuss the status and trends of geography in Germany, America, Britain, the French-speaking Lands, Italy, Japan, Netherlands, Poland, and Scandinavia, in *Geog. Zeits.*, 44. Jahrg., 7./8. Heft, 1938.

³ Bowman, Isaiah, *Geography in Relation to the Social Sciences*, New York, 1934. *Geographie in den Vereinigten Staaten nach dem Kriege*, *Zeits. der Gesell. für Erdk. oden*, Breslau, 1937.

Vallaux, Camille, *Les Sciences Géographiques*, Paris, 1939.

objectives, a self-consciousness that may well inhibit geographic expression and stultify conclusions? Friederich Ratzel tried to dispose of this whole matter of method briefly by saying, "Of what use are all the methodologic and programmatic performances? First produce something, from that method will become known." It is not settled so easily, however, because questions of this kind continue to rise in the minds of many geographers and of their colleagues in border fields who have been in touch with geographers and their ideas. They are questions which this writing can hardly presume to answer to the satisfaction of many, much less of all.

GEOGRAPHY IN THE FIELD OF SCIENCE

Geography is sometimes looked upon as a youthful plant in the field of learning, having a definitely bifurcated root system which it pushes into the feeding grounds of the natural and the social sciences respectively. It may fairly be questioned whether this kind of root spread is in fact more distinctive of geography than of some other fields of learning and whether the apparent bifurcation is not a normal sort of root divergence such as one may recognize in the soils and subsoils from which various of the plants of knowledge draw their sustenance.⁴

Our geographic plant truly is very old, not young, but it is not yet mature. Its development has been arrested by a continuous process of detachment of the products of its growth. Scientific techniques, budding from the parent stem of a Renaissance cosmography grew into branches seeking the light, each in its own direction. Then, like the mangrove shrub, each has put down its adventitious roots and started its own scientific existence. The result is a thicket in which the parent plant occupies no conspicuous position, and, to some, is not even clearly distinguishable. No one doubts its existence, but where geography begins, where it ends, and what its functions are is a subject of debate that has involved all of us. Why this argument should revolve so closely around the parent stem, why the offshoots should feel their spheres of activity so clearly given, is not plain. Perhaps it rests upon the assumption, widely held by scientists, that each branch of science, once its relative independence is established, should be kept free from all entanglements; that the fruit of each branch is produced for its own sake; science solely for the sake of new knowledge. But science would be less than scientific if it did not admit the possibility of erroneous assumptions, and so this one certainly may be called into question.

It is hardly necessary to review here the various phases of thought through which the geographical profession has been led in recent decades.

⁴ Penck, Albrecht, "Geography Among the Earth's Sciences," *Proc. Amer. Philos. Soc.*, Vol. 66, 1927, pp. 621-644.

The subjective theses of the Ratzelian school have given way, but not without contributing their elements of truth. The geomorphologists have studied objectively and analytically the physical configuration of the earth's surface, and their task is far from being finished. The environmentalists of various shades of positiveness have attacked the subject of a general world geography only to find themselves all too often postulating the things they were to discover and then discovering them, regardless of contradictory evidence. In sequence we find the topicalists in the field of human geography. These, finding, so to speak, that they could not swallow the whole meal at once, have taken it by courses. We have economic geographers, commercial geographers, historical geographers, political geographers, the culture-form geographers and others. Even the courses in some instances have proven too abundant, they have been apportioned, and there have emerged specialists in agricultural geography, industrial geography, and those who concern themselves with studies in the realm of the destructive exploitation of earth-given resources by mankind.

Running through the literature of geographic methodology are the repeated statements of those who find it often more expedient and just as reasonable to attack a vast complexity in another manner. Baffled by the largeness of a general geography, they would reduce it to manageable portions by an examination of the significant manifestations of man and nature in their "togetherness" in a limited area of the earth's surface. This school of regional geographers, the chorographers or chorologists, has produced a voluminous literature. Its method has developed to the point where reaction has set in against it.

It is not my purpose to dissect the current skepticism of a science of regions to discover its elements of weakness or soundness. I propose rather to try to show how that field of investigation looks to some who do believe that it has scientific validity. If that is evasion of an issue, it is at least justified by the fact that many geographers do believe in it.

What does yet remain the field of the ancient geographic plant? By what methods can its cultivators hope to nurture it, and what kind of fruit may they anticipate? Is regional geography as a field of learning amenable to the methods of the sciences, or must it, as some are maintaining, turn mystical and produce fruit only in the realm of literary art? Certainly the answers currently given to these questions are not unanimous, neither are they clear. They rest upon so many and so different postulates of logic that they become almost matters of personal opinion.

What, in fact, is the position of the regionalists with reference to the objects of their study? It has been called uncritical. Even if this charge fails of substantiation, it can hardly be called uniform. Some there are

who would defend their areal dissection of the earth's surface upon logical grounds. Others are willing to admit that their choice of areas for study may currently be somewhat arbitrary or even fortuitous. But they express a conviction that means for a more systematic selection will appear as a result of more regional research. Whatever their positions in this regard, their belief in the scientific validity of this mode of geographic study is substantial. Various statements confirm this point. In his address before this Association twenty years ago⁶ Fenneman said, "the one thing that is first, last and always geography and nothing else, is the study of areas in their compositeness or complexity, that is *regional geography*." This clear and simple declaration has not been accorded the attention to which it is entitled as compared with others which have enshrouded similar viewpoints in more elaborate verbiage. Equally clear is the intent of a recent assertion of J. G. Granö, which says, "In our opinion, geography is valuable and is justified as an independent science only in case that it studies the areas and provinces of the earth as entities."⁶ Hettner likewise expresses himself in certain terms. He says, "The geographical way of thinking can by no means be anything other than chorological any more than the historical way can be other than historical and the systematic way concerned with things."⁷ The intent of such positive and overt statements may be supported by many others that are made more or less directly or by implication.

Many students of geography have accepted as reasonable the general theme of chorology. They have recognized the difficulties of dealing with the large number of physical and cultural features coexistent in an area. They have felt, however, that regions were realities, that they could be defined in terms of critical elements; that these elements and their characteristic associations were amenable to analysis, symbolization, description and explanation. They have felt that the meaning of these elements, both features and events, were capable of synthesis into a rational understanding of an area, albeit never perfect in its completeness. They have felt, moreover, that, in proceeding by these means to the end of a general understanding of man and nature in an area, they were following reasonably scientific methods and were doing respectable work of a scientific order. Whether it was natural science or social science, granted any known line of demarcation, has concerned some to the point of argument about it. In the main, however, that has been a problem of administration rather than of scholarship.

⁶ Fenneman, Nevin M., "The Circumference of Geography," these *Annals*, Vol. IX, 1919, p. 7.

⁶ Granö, J. G., "Geographische Ganzheiten," *Peterm. Mitteil.*, 81. Jahrg., 1935, p. 297.

⁷ Hettner, A., *op. cit.*, p. 123.

Opposed to the above and other unequivocal declarations of the scientific status of geography as a chorologic discipline there are qualifying and dissenting voices. Some would defend regionalism, but with reservations. They do not find a satisfying scientific basis for regional study in regions delimited in terms of the genesis of their features. Neither do they find it when definition is made in terms of concomitant distribution of features, nor in the possibility of an innate natural unity of forms, intangible but real. They would have us, instead, turn from the static to the dynamic to find the basis of regional entity, from things to processes; for example, from railways to transportation.⁸ Most regionalists would agree that the treatment of area should include its dynamic phases.⁹ Thorough regional treatments do include it. But to make the things that "do not lie open to the eye" the sole basis of regional organization can hardly be expected to increase the rationality of this approach. It is more likely to heighten the intangibility of that which already is elusive.

Some, however, would go much farther and deny any sort of scientific validity to regional studies.¹⁰ They would put chorologic methods and conclusions squarely in the realm of art, purely subjective, and perhaps impressionistic, unless a region lay in some remote spot untouched by man the artificer. This conception imposes a limitation upon method. It leaves the geographer, if he would achieve otherwise than as an artist, no alternative. He must turn his attention to the physical aspects of the field; physical earth in some one or all of its manifold features, or to the physical features of human culture, if perchance he can stake out there a claim not already pre-empted. In the main, it would seem that the young geographer imbued with zeal for science and faced with the restrictions of this philosophy, must be driven into a multiplication of scientific minutiae; microclimatological studies, reexaminations of the detailed characteristics of land forms and other similar researches. It is far from my intention to disparage the work being done in these fields. On the contrary, it has general admiration. Much remains there to be discovered, and for those who find satisfaction in cultivating such aspects of the whole of earth features, a worthy scientific goal. But, having an innate interest in such studies, on the one hand, and, on the other, being driven to them through fear of losing scholarly caste are two quite different states of mind. The chorologists hold that attempts at a scientific regional geography have produced and can produce understandings of value. If that is true, to permit one's self to be driven

⁸ Crowe, P. R., *op. cit.*, p. 14.

⁹ Krebs, N., "Der Stand der Deutschen Geographie," *Geog. Zeits.*, 44. Jahrg. 7/8. Heft, 1938, p. 244.

¹⁰ Leighly, John, *op. cit.*, p. 131.

into detailed systematic studies can only be, it seems to me, a monkish retreat upon minutiae when faced by the complexity of regional facts. Logic which appears to compel such a course may be subjected to question. Certainly, between the positivism of the convinced regionalists and the negative position of the skeptics there is, with reference to the scientific validity of regional geography, a great gulf.

The specific question whether the heterogeneous features of nature and culture, bound together only by the fact of their occurrence in a given locality, are amenable to scientific treatment has been raised by others than geographers. One writer on the philosophy of science,¹¹ cites geography as typical of the synoptic sciences, and asserts that its material obviously is drawn from a variety of other sciences. He questions whether it contains any unique subject matter, or is not merely the study of interrelationships between other fields of science. This point of view contains a triple weakness. It assumes that sciences, other than those classed as synoptic, do not deal largely with facts drawn from other sciences. It assumes that synoptic sciences do not create new and valuable ideas or understandings out of the study of such relationships. Moreover, the rhetorical question concerning the uniqueness of the subject matter of geography does not show a profound acquaintance with the field. Does not the science of mineralogy, for example, involve the study of relationships between chemistry and physics as applied to a selected class of phenomena? No one thinks, however, that such a statement of relationship defines the field of mineralogy. Is not forest science more than merely the study of relationships between plant physiology, climatology, pedology, parasitology and other fields of science? Mineralogy, forest science and every science involves an interrelation of facts from many sources, but from them each draws its own inferences and with their aid makes its own explanations. The viewpoint cited above fails also to take account of the study of facts and the interrelationships between facts discovered by geographers for their own specific ends, by their own techniques, in or on the margins of the border fields. These techniques and these facts belong to geography, and from them and its gleanings from the other sciences it creates new facts and new insights. Vallaux touches this point when he says that it is only in description and for description that geography borrows. "It does not borrow from the field of any other science, from the viewpoint of explanation."¹²

PHYSICAL GEOGRAPHY VERSUS REGIONAL GEOGRAPHY

It has been indicated above that the field of physical geography holds

¹¹ Benjamin, A. C., *An Introduction to the Philosophy of Science*, New York, 1937, p. 406.

¹² Vallaux, C., *op. cit.*, p. 66.

attraction for the geographer who wills that his mode of scholarly activity shall be scientific. In this field there seems wide scope for critical investigation. The generalizations and schematic representations of an earlier day are being subjected to further scrutiny. Accepted principles of geomorphology and aerodynamics are being called into question. New concepts are evolving in hydrology and pedology. Although the principal responsibility for advances in these border fields of physical geography rests with the specialists in those fields, it does not follow that the discovery of new facts and the evolution of significant viewpoints will come exclusively from those sources. Geographers, with their eyes on the broader relationships of earth features, have made some of the important contributions there and are likely to make more. It is a worthy endeavor, but is it one that is likely to release the geographer permanently from the difficulties inherent in the attempt to understand regions by scientific means? What are the objectives in these distinctively geographical researches in the field of physical earth? Is it merely the satisfaction of knowing in greater detail the facts of form and genesis concerning arbitrarily selected features? That may be the immediate stimulus, but the ultimate goal is regional understanding. Upon what grounds are the old concepts of geomorphology being called into question by geographers? It is upon two grounds, *viz.*, that their generalizations are not adequate to describe and classify all the facts considered significant in the present-day study of land forms in their areal associations, and that their conceptions of form and genesis do not fit the facts in specific regions. What is the probable function of microclimatological studies? Is it supposed that infinitely detailed and careful studies of storm behavior in Ohio will evolve new facts and new insights that may be generalized into laws which will be true of the behavior of storms in the Lake Superior region, or South Africa, or China? If so, it is not yet admitted. It is maintained, and with reason, that such studies may throw light upon the associated features of the areas in which the studies are made. Consciously or unconsciously, therefore, the microclimatologist is operating within a regional framework. He differs from the regional geographer in that he delves to the limit of his time and techniques into one element of the areal complex while the chorologist gropes for the whole. The geomorphologist or the microclimatologist has indeed removed from his immediate consideration a multiplicity of facts concerning the other realms of physical earth, and, above all, he avoids dealing with the behavior of a supposedly unpredictable humanity. But, implicit in his performance is the hope that workers in other sciences will add necessary details of regional knowledge and that eventually there will appear a correlative understanding of higher value. We may question whether this is not

a vain hope, or at best one of greatly delayed realization. The regionalist, bold soul, proceeds upon the conviction that the knowledge of details never will be complete and that some kind of unified comprehension of the areal complex is better than none. He therefore makes as careful observations as he is able, collects such pertinent facts as he can from the works of the topical specialists, fills in significant gaps by the application of such techniques as he has or can borrow, adapt, or invent, discovers some new facts and gains some new insight. He then attempts conclusions in a form and with a logic which he hopes are more precise than the impressionism of art.

Important as they may be in themselves, are these distinctions between the positions of the physical geographer and the regionalist sufficient to guarantee to the follower of the one discipline as compared with the other that more deep and lasting satisfaction in scholarship which is supposed to be inherent in a scientific method? Define science as you will, each of these methods of work has its strengths and its weaknesses. It may be questioned whether one yields to the other in its ability to present new facts and new insights. It is questionable whether one is making notably more progress than the other in discovering meaningful uniformities in the field of the earth's surface conditions. The one removes itself farther and farther from the realm of the general by particularizing about one class of phenomena which varies with change in locality. The other complicates the matter by considering several classes but simplifies it by restricting the areal units to which the method is applied.

The difficulties faced by the regionalist are indeed many and perhaps, in part, insurmountable. He is forced to understand the meanings of the data furnished by many other disciplines and sometimes to a limited practice of their methods. He is forced to invent techniques to his own ends for the purposes of observation, symbolization, analysis, description, explanation and synthesis. Above all, he occasionally has the exalted hope that in some way, at some time, his labors may be of almost direct service to his fellow man. Perhaps the skeptics are right, and the regionalist may be forced to admit that the complexities of man and nature in area are too much for his abilities at rationalization. Yet here *are* the realities of regions everywhere about us. We live in them, and our lives are economically nurtured and politically administered by regions defined in some terms. No other discipline concerns itself with regions as does chorology, and even though a Vaughan Cornish did fail, as it recently has been pointed out, to found a science of "kumatology" in an unpreempted field,¹³ the analogy does not of necessity apply to regional geography. Incidentally, Cornish proposed also to establish "Aesthetic Principles of Town and

¹³ Leighly, John, *op. cit.*, p. 130.

Country Planning."¹⁴ If that was an attempt to generate an appreciation of art in topography, it has been no more successful than his kumatology. Perhaps if we continue with the attitude of realism which has been the viewpoint of many geographers, present and past, we may improve our methods to the achievement of ever-clearer understandings of the complex and integrated features of specific areas.

REALISM IN REGIONAL GEOGRAPHY

No geographer is unaware that chorology, in the sense of a complete, wholly consistent, and strictly rational regionalism is difficult if not impossible. The problem of the necessary alternatives of regionalism and topicalism in geography has been well and briefly stated by Hettner.¹⁵ He suggests that the various classes of areal conditions be thought of as strata upon the earth's surface, and says that, since the human mind cannot grasp all these in their entirety at once, it must do so from two different viewpoints in sequence. First, a lateral view, beginning at the bottom, shows the various features of each specific category. This, if carried out for the whole world is general geography. Second, if viewed from above as a transparency, the earth would show one after another, the areas of a regionally compartmentalized landscape. This, he says, is the basis of regional science. However, the areas are not held together by any inherent necessity and the structure is therefore a loose one. He adds, pointedly, that one who "pursues the individual phenomena in sequence can well understand them but misses the spirit of geography which resides precisely in the comprehension of the unity of the phenomena of nature found in a given place."

It is hardly necessary to restate here the details of reasoning opposed to a scientific regional geography. Some of the more penetrating criticisms may be reviewed in brief to bring them into focus. It is maintained that regions cannot be scientifically delimited because the diversity of genetic forces operative in the origins of all the areal elements offers no universally applicable basis for co-delimitation¹⁶ and because delimitation upon the basis of mere concomitant distribution of those elements believed to be critical involves subjective, and therefore non-scientific, assessments of value.¹⁷ For much the same reasons, it is held that regions cannot be described as they really are, or explained, except in terms of a series of sequent explanations of the individual elements which, more or less fortuitously, occur within a given area. These and other contentions are made with cogent

¹⁴ *Scot. Geog. Mag.*, Vol. 49, 1933, pp. 321-323.

¹⁵ Hettner, A., *op. cit.*, p. 218.

¹⁶ Leighly, John, *op. cit.*, p. 128.

¹⁷ Crowe, P. R., *op. cit.*, p. 8.

logic. Even if one is willing to grant the correctness of the logic, there remains a question as to the soundness of the assumptions upon which it rests. There remains also the incidental question whether regional geography has any peculiar unsusceptibility to scientific treatment, or whether it has only some of the ills common among the sciences but perhaps has them in more obvious forms. Can it be shown whether regions, as the chorologist treats them, have any reality? Can geographers who continue the attempt to delimit, describe and interpret earth features by regions have any basis for scholarly satisfaction outside the artistic method which the skeptics admit to respectability; outside the treatment of process and change which some would make the organizing principle of regions? Can any clear answer be given to the question, recently asked in a meeting of geographers, whether the regionalist, even in the classroom, is scientist or mountebank?

ARE REGIONS REALITIES?

Many geographers have pondered over the nature of regions. They have asked themselves whether selected localities, including the complex associations of features, patterns and functions attaching thereto, are proper objects of rational inquiry. Their general conclusions are affirmative and have been stated often. In one connection or another, most of them have professed a belief in some sort of areal association of features which has distinctive, unitary, and knowable characteristics. More than that, the idea is one in common usage. Such terms as the Upper Great Lakes Region, the Po Basin and the Karoo are not mere geographical jargon. These areas, whether they are defined in terms of one or of more than one set of physical or cultural forms, are complex realities whose existence is recognized by the people who live in or near them.

Are regions, as they are treated by the practical chorologist, in fact, distinctly less real than many of the objects commonly taken under observation in other sciences? Such "objects," it is recognized by the realist in any science, seldom are simple elements. The elements, determined objectively or subjectively, are found to exist together in associative wholes which themselves become the objects of investigation. It is observed in all sciences that the integral character of objects does not depend alone upon their persistence and recurrence but also upon the fact that changes commonly occur in groups; changes in some of the elements being accompanied by changes in others.¹⁸ This general principle of scientific method, the means by which the scientist recognizes and isolates the object of his inquiry, needs little modification to be applicable to the acts of recognition and isolation in chorologic method.

¹⁸ Benjamin, A. C., *op. cit.*, p. 89.

It may be argued, however, that the objects taken under view by the other sciences are in general less complex and more tangible than the objects of regional geography. It would be difficult to maintain the universality of that thesis. A region, with all its classes of elements and functions is hardly more complex than the principal object of study in human anatomical science. Also, many regional features have qualities that lend themselves to direct sense perception. Consider, by way of contrast, only that hypothetical entity the atom, none of the characteristics of which are known except by indirect means.

In the face of the great complexity of geographic regions, is it defensible, from the standpoint of empirical science, to define them in terms of *some but not all* their characteristics? It is a fact that regions, as they actually are treated by geographers, generally are delimited arbitrarily in terms of one or more but not all their elements. They are therefore, in a sense, mental constructions rather than clearly given entities. The logical manner of construction would be, of course, from minutely individual entities upward by a controlled synthesis of facts, following the method applied by Passarge to the natural elements of regions. It is to this end that certain techniques of field observation have long been worked upon by members of this Association. However, the gathering of so great a body of detailed facts for large areas is too slow a process for wide use. Detailed analysis of even the static features of area has so far been used mainly in type studies to distinguish localities. We know from written statements as well as from general experience that regional definition still is largely a subjective process. Passarge, however he would build up his natural realms, admits that "geographic realms are ideal realms which the scholar brings into existence by considering the phenomena essential for the landscape picture."¹⁹ Granö holds likewise that "geographical research forms the entities of which it is in need."²⁰ This, he says, is done by science from the extreme complexity of regional content through a planned simplification and analysis of that which is essential to the purpose. The purpose, in his mind, is to make new and clear entities that correspond to reality. Hettner maintains also that chorologic method is justified in omitting from consideration many "forms, material conditions and manifestations of spiritual life" which for other disciplines may perhaps be most important facts.²¹ He even goes so far as to state that the importance of regional facts depends upon the amount of their influence on other re-

¹⁹ Passarge, S., "Wissenschaftliche Geographie, Ihre Lehr- und Forschungsaufgaben," *Peterm. Mitteil.*, 81 Jahrg., 1935, p. 342.

²⁰ Granö, J. G., *op. cit.*, p. 296.

²¹ Hettner, A., *op. cit.*, p. 130.

gional facts.²² Geography, in his opinion, focuses its attention only on data that express themselves directly or indirectly through the regional totality.

It is clear that valid defense of this kind of procedure must come also from the broader base of a general philosophy of science and not from geographical necessity alone. Benjamin, in discussing the techniques of all descriptive science, makes a point which bears directly upon the matter. "Perception," he says, "is incapable of grasping events of more than a moderate degree of complexity, whether the complexity be spatial, temporal or qualitative. Hence attention proceeds by focusing itself upon that core of the perceptual field which is considered to be especially relevant, and by either neglecting the remainder entirely or else merging it into the background of consciousness and attending to it only vaguely. In this way simple events and events of only a moderate complexity become isolated from their environmental associates and considered as individuals." He adds that "It is recognized that the neglect is not necessarily a denial of the existence of the associates but merely a disregard of them for the purpose of the problem in hand."²³ If a judicious selection of the facts to be considered by a group of workers is, as those who are skeptical of the methods of regionalism imply, a proper basis for the formation of only a cult—but not of a science,²⁴ then it appears that all the sciences must be guilty in some degree of cultism. So broad are the ramifications and interconnections of scientific knowledge that no treatise is undertaken and no thesis defended without selecting from the available facts those most pertinent to the consideration. And, the individual scientist and his critics are the judges of pertinence. Is it not possible that the practices followed by modern geographers in the distinguishing of regional entities upon the basis of material features of landscape, arbitrarily selected, has as good justification in scientific method as regions delimited upon a basis of "organization," or land forms, or climatic conditions, or any other fact or group of facts? Indeed, one might even go so far as to define a region as an areal convenience delimited for a purpose. Different purposes require regions of unlike definition. Geographic purpose seems to require definition in terms of both physical and cultural phenomena, forms, patterns and functions, from among which certain are conceived as determining areal character and individuality.

Are we from this viewpoint, entering the realm of unlimited possibilities, so far as geographic regions are concerned? Are we trying to

²² *Ibid.*, p. 238.

²³ Benjamin, A. C., *op. cit.*, p. 111.

²⁴ Leighly, John, *op. cit.*, p. 131.

discover rules in chaos, in a medley of incomparable units incapable of analysis? The answer to that lies, it seems to me, not so much in philosophy as in the practical common-sense recognition of general earth regions by non-geographers, and the belief that such regions of different orders of magnitude have a real significance. Much the same situation exists in cultural anthropology. The criticism of theoretical non-concordance leveled at culture areas delimited in terms of different aspects of culture is met, according to Kroeber, by "the apparent fact that the culminations of these aspects tend actually to coincide in the same areas."²⁵

The problem of a unified chorologic method does not seem to lie in the difficulty of justifying the recognition of regions. It is in the difficulty of getting geographers to agree upon a means for determining the general significance of locally important features which it is proposed to use as the organizing principle in regional studies.

Permit a passing reference to the matter of bounding the geographic region. One would suppose this to be no longer a problem, but it has been raised again.²⁶ Clearly, the characteristics of a region should be most pronounced in its interior, and a logical description of it should, as Vallaux has said, proceed not from the center to the circumference but from the circumference to the center.²⁷ Regions end in transition, seldom in definite boundaries. The areal complex is substantial; it is only its boundary that is inclined to be capricious. Certain maps which purport to show regions, some geographers find objectionable because in fact they show little other than boundaries. There is nothing inherently wrong with such maps. They reflect no more than the lag of cartographic techniques behind chorological thinking.

REGIONS AS KNOWABLE OBJECTS

It is conceivable that regions may have reality and still be, in fact, comprehensible only in the subjective terms of art. For the present purpose it is therefore necessary to inquire whether they have in reasonable degree the characteristics of knowable objects of science. Their elements should be, as many regionalists hold that they are, susceptible of observation, analysis, description, classification and other treatments required by scientific method. It is obvious that many of the elements of regions are observable things. This is important, because observation, as Krebs puts it, "is and remains the basis of geography."²⁸ To be sure, the activities and

²⁵ Kroeber, A. L., "Culture Area," *Encycl. Soc. Sci.*, Vol. 4, p. 646.

²⁶ Crowe, P. R., *op. cit.*, p. 10.

²⁷ Vallaux, C., *op. cit.*, p. 107.

²⁸ Krebs, N., *op. cit.*, p. 246.

forces of human dynamics, in which some would see the essentials of regional unity,²⁹ are not all amenable to direct observation, but we gain awareness of them by only slightly different means. They are recognized by all regional geographers.

If a region is a scientifically understandable object it should be capable of analysis into its component objects and events. This is, as every geographer knows, a necessary part of regional method. The accomplishment seldom is perfect, but the method is universal. Analysis is the process by which the chorologist attempts to show that the unity of his region may be understood in terms of the properties of its component elements, or, conversely, that the properties of the elements may be clarified in terms of their togetherness. It is the shifting from the vertical to the lateral viewpoint of Hettner, or *vice versa*. For analysis there is no standardized logistic technique,³⁰ and it is assumed that chorologic method may make as appropriate use of it as any science.

Synthesis, of which much is said in chorological writing, has, it seems to me, little place as an investigative procedure in regional method. The processes of nature and the acts of man have together performed a synthesis of regional elements. It is the geographers' task to analyze as a movement in the direction of explanation. The written synthesis is, for the regional geographer, a technique in the presentation of the results of analytical investigation, not itself a means of investigation.

Another of the procedures necessary to descriptive science is symbolization. In its ability to symbolize the data with which it deals chorology is well developed. There is a rich terminology available for verbal symbolization, although new terms continually are needed. Techniques of measurement, cadastral and statistical, some developed by geographers, more derived from its border fields, enable reasonably explicit characterization of areas, forms and distributions. Graphic and cartographic techniques have been devised for the symbolization of chorologic facts, and more are certain to be invented for the expression of new ideas of kinds amenable to graphic representation.

With the rudiments of an analytical method and rich resources for symbolization at its command, there should be no inherent difficulty in regional description. Difficulties there are, innumerable, of form and detail, but they are not deep or insuperable. Indeed, it is upon the grounds of their achievements in description that the regional geographers have mainly rested their claims for admission to the realm of empirical science. They are aware that much of the factual material with which they deal is not yet seen to be conformable with any general explanatory hypothesis.

²⁹ Crowe, P. R., *op. cit.*, p. 11.

³⁰ Benjamin, A. C., *op. cit.*, p. 194.

But, they maintain, and with reason, that the same is true of other sciences, such as biology and psychology, in which living organisms are studied. The partition between the empirical and the rational sciences probably is in truth, like the boundaries between regions, no line at all, but a transition.

In so far then as chorology describes regional phenomena, including both forms and dynamics, it may lay claim with reason to a place among the empirical sciences. That many of the facts which are taken by the regionalist for his purposes are derived from researches in border fields may not be held against this position. The same is true in other fields, since even the purest of rational sciences are not entirely self contained. The geographer also discovers his own new facts of form, pattern and function with his own techniques in the realm of the areal association of features. Neither may the fact that some of the raw materials with which he works are not naively given be considered finally prejudicial to his position. Not all facts either are or are not naively given; they are given with varying degrees of naïveté, and in any science the scholar must work with all classes.

Basic to any descriptive science is its classificatory function. Here, admittedly, chorology is weak. It has voluminous classificatory systems for the elements of which regions are comprised, but in the main these have been developed in its border fields, especially physical geology. Regions, as such, the very center of chorologic thought, remain unclassified and perhaps unclassifiable. Classificational systems generally are arbitrary, although they are not without reason, but as yet not even an arbitrary system has been devised of sufficient elasticity to bring into rational order the apparently non-repetitive regional totalities with which chorologists deal. Some attempts to lay the foundations of regional classification have been made, but none of sufficient penetration to gain general acceptance. On this point American geographers at least divide into two camps. There are those who hold that it is beyond reason to hope for the development of a workable system of regional classification. The attitude of many others may be described merely as still hopeful. The hope they entertain rests upon the belief that the difficulties of classification experienced in the early history of other sciences may be analogous to those the regionalists now encounter. It is, they believe, possible that new techniques of investigation and, above all, a deeper insight into the properties of regions in general may reveal inherent likenesses and differences not now understood. This, it must be admitted, is in contradiction of the general trend of experience which, with the growing mass of facts, shows a variety of detail which requires the subdivision of every region into its sub-regions, areas and localities, the last named of which are practically individual. Therefore, because

of the present multiple basis of classification, no classificatory system for the regions of the world has progressed much beyond the elementary stage of the telephone directory. Individual localities are catalogued, but the only broadly applicable basis of inter-regional reference still is position on the surface of the earth. The names which are the basis of index in the telephone directory tell us something about the individuals classified but not much about their mutual interrelations. Except with regard to some generally accepted ideas about magnitude, there is as yet no clear concept of order as applied to the regions of the geographer. In the full sense of all their component features regions probably are non-repeating entities. Whether they are so from the standpoint of some acceptable set of critical phenomena is another question.

It is an interesting fact that, while the classificatory aspect of chorology is but poorly developed as applied to regional entities, the correlational function, as applied to the features of individual regions, is highly developed. Bowman says that the main purpose of geography is "regional analysis and, if possible, correlation: the identification of interrelations, the way in which the forces of environment 'hunt in packs' and produce group effects."³¹ That is of course only a partial statement of the kinds of relationships the regional geographer attempts to clarify. It is a most important scientific function, this discovery of the togetherness of certain classes of earth features, physical, or cultural, or physical with cultural, and is basic to the explanatory function of geography. Difficulty lies in the fact that geographic correlations are not quite of the same order as those in the exact sciences in which they are presumed to have wide validity and to exist of necessity. Even there, however, truly universal validity can hardly be proven. In chorology not even correlations between the physical features of regions are presumed to have world-wide application. Those between the physical and the cultural may be areally quite restricted. However, it is not the concern of descriptive science to maintain the universal correlation of certain phenomena. It asserts merely their occasional or frequent association. It remains for the explanatory function to demonstrate the degree and applicability of that relation.

EXPLANATION IN CHOROLOGY

The foregoing has attempted to show ground for a belief that chorology has in reasonable degree the characteristics of a descriptive science. That ground being admitted, there arises a further question whether it may properly be said to evolve the conjectures and hypotheses which entitle it to be considered to perform an explanatory function in its own right.

³¹ Bowman, Isaiah, *op. cit.*, p. 146.

"Geography," says Bowman, "takes the earth region by region and as a whole and works out such conclusions as its data warrant: as in all human studies the descriptive element is large, the explanatory element small."³² Vallaux, on the other hand, is at great pains to emphasize his belief that not only is explanation the highest function of geography, but that geography has its own processes of accomplishing that purpose, although, as he admits, explanation carries with it the danger of prematurity and an "excess of constructive imagination."³³ Certainly geography explains or attempts to be explanatory. Chorology as pure regional description would be a dry thing and could hardly lay claim to scientific standing. Chorological description alone is no more than a symbolization of a regional association of facts. The mere facts of regional description without the understanding that comes through interpretation, valuable as they certainly are as a record of regional inventory, carry us but little beyond the threshold of understanding. Explanation expresses a relation between features or between their symbolizations. It is through explanation that the hidden meanings of the regional associations are demonstrated and the forces that stand behind them are made clear. It is thus that new facts and new insights are developed by chorologic method. Some may argue that the inclusion of the works of man as well as the forms of nature within the scope of chorologic observation removes such observations from the realm of rational interpretation. However, it is recognized in the philosophy of science that it is possible for the social sciences to become explanatory although it may require hypotheses of "final causes and purposes."³⁴

It appears therefore that explanation, more or less completely rational, is not only possible in regional geography but actually is a vital part of its method. If this is admitted to contribute to its scientific quality, further questions arise. Are the hypotheses employed of general application? Can they be so stated as to become a basis of chorologic prediction? And, are they subject to verification? Attempts to answer these questions must be brief.

Chorologic hypotheses are advanced with caution and are made applicable to the explanation of only limited phenomena or associations of them in restricted areas. This being the case, the classes of explanatory hypothesis employed in chorological reasoning are not presumed as yet to have wide, to say nothing of universal, validity. They are particular for limited sets of conditions. In this respect the regionalist has learned caution from the anthropogeographical school of a generation past. Their sweeping hypotheses, it now appears, too often were verified by a pains-

³² *Ibid.*, p. 119.

³³ Vallaux, C., *op. cit.*, pp. 66, 68.

³⁴ Benjamin, A. C., *op. cit.*, p. 205.

taking selection from the available evidence. Certainly there is not now in regional geography any broad and well-formulated body of hypothesis. Perhaps there never can be. We must not overlook, however, the grounds for explanation kept in mind by the well informed student of a region about the features and problems of his own area. Whether or not these are the fragments which may one day be welded into a more imposing body cannot now be foreseen. In any case, they are comparable to the hypotheses held in mind by innumerable scientists concerning the apparently unrelated minutiae of their respective areas of the realm of science.

Admitting the lack of a general body of chorological hypotheses, can there be made any valid predictions as to the probable or desirable trends in regional development? Apparently not, in any general sense. The variables are entirely too many and too little known. This denial may not be so promptly made, however, with respect to a limited area and the predictions of a chorographer thoroughly acquainted with it. Some would not admit that prediction for the future trend of events in even a limited area could be valid because of its inclusion of unpredictable human behavior in relation to even the known conditions of physical environment. This viewpoint involves again the bothersome question whether there is need for any sharp cleavage between the natural and the social sciences. A recent paper on social science makes an appropriate comment that "if the sociologist were willing to act on the assumption that his science is natural he might be surprised at the fruitfulness of his trial."³⁵

It is necessary to inquire further whether chorological hypotheses and predictions, if any, can be subjected to verification. Here again the limitations imposed by the nature of regional data can not carry its method far. Verification must be made largely upon the basis of observation and analogy. These seem a flimsy structure for so important a function. Nevertheless they are a part of the structure upon which the verification of all scientific hypotheses rests. Confirmation of explanatory guesses must be made by returning for further study to the features upon which the intuitive function was exercised and to others of similar kind. Experimental procedures usually if not always are out of the question in geography. Control of the object of his study is beyond the chorologist's ability. Time also is a factor in the testing of his explanations. But these conditions attend also some of the explanations of the astronomer and the geologist, not to mention workers in the field of social science.

These reflections, incomplete at best, have seemed to indicate that regional geography may be practiced through methods that are broadly scientific in nature. Not even its most ardent practitioners would maintain

³⁵ Fries, H. S., "Social Science and Human Values," *Jl. Social Philos.*, Vol. 3, 1937-38, pp. 54-58.

that its findings are as sure as those of the physical sciences. Many of them would hold, however, that its portrayal of areal reality has greater penetration, reason and relevancy than the subjective treatments of painting and the literary arts. Vallaux has made this point with force.³⁶

As a final qualification for inclusion in the ranks of the scientists the chorologist stands ready to change his conclusions when impelled by the force of new facts to do so. Just one hundred years ago W. R. Hamilton, in an address to the Royal Geographical Society, described geography as so peculiarly a progressive science that it was a continual correction of errors.³⁷ But he added that, as in astronomy, these errors must be considered the truth until they are corrected. Hamilton was referring to the exploratory geography and mapping of that day, but his words still have value. The present-day regionalist assumes that his regions must stand the test of the same philosophical treatment accorded the objects of other sciences, with the discovery of the same kinds of errors, even including the possible discovery that they do not exist.

CHOROLOGY AND REGIONAL DYNAMICS

Granting that regional method has scientific validity sufficient to entitle those who practice it to a feeling of intellectual respectability, one may ask whether it is capable of an adequate representation of the geographically important aspects of regional dynamics. Are regions as they commonly are delimited capable of such treatment as will show them to be "active and growing entities," or must they be delimited upon the basis of "organization" to achieve that end? Would the latter basis of delimitation, in fact, resolve any of the difficulties inherent in regional method? Are the functional activities of areas less complex than their visible forms? Are these activities less subject to intermingling and overlap so that their areal limits are more clearly given? Experience indicates to the contrary. There seems no escape from the conclusion that regions must be defined to suit one's purposes. The basis of functional activity is as acceptable as any other, but its status can hardly be preferred.

On the other hand it would be a poor treatment of a region, whatever the basis of its delimitation, that did not recognize it as an active and growing entity. It is, without doubt, this feeling for the pulse of life in a region that has led some chorologists to treat their regions as organisms,³⁸ an

³⁶ Vallaux, C., *op. cit.*, pp. 95-101.

³⁷ Hamilton, W. R., Presidential address to the Royal Geographical Society of London, *Jl. Royal Geog. Soc.*, Vol. VIII, 1838, p. lii.

³⁸ Musset, R., "Der Stand der Geographie und ihre Neueren Wissenschaftlichen Strömungen in den Ländern Französischer Zunge," *Geogr. Zeits.*, 44. Jahrg., 7./8. Heft, 1938, p. 275. See also Sauer, C. O., "The Morphology of Landscape," *Univ. of Calif. Publications in Geog.*, Vol. 2, No. 2, p. 26.

analogy to which some other geographers object.³⁹ No other descriptive science can avoid the inclusion of the dynamic phases of the objects of its inquiry, and the same certainly is true of chorology. Regional literature is too well filled with statements and discussions, both explicit and implicit, for the matter to require elaboration.

REGIONAL GEOGRAPHY AS A HUMANISTIC EARTH SCIENCE

Another phase of the general theme of regionalism that seems to need comment is the status of chorology among the sciences, not in the classificational but in the functional sense. This position implies a point of view with respect to all the sciences or science as a whole. Is there a valid social point of view with respect to the sciences as well as a scientific point of view with respect to society? Such a viewpoint has made itself known and is rapidly gathering adherents. Certain movements make it clear that scientists are themselves increasingly willing to accept some responsibility for the social repercussions of scientific discovery. As evidence of this one need only read the comments of nearly forty British scientists on a recent proposal that all scientists organize for the purpose of studying the social relations of their work.⁴⁰ With few exceptions they show keen awareness of a need for an integrating principle for the sciences and a means of bringing that principle to bear upon social problems. Some of them specifically deplore the necessity that has enforced a scientific preoccupation with small parts of all reality and wish for means to recover a grasp of the whole, realizing, however, that "the study of wholes is never such a simple and straightforward business as the study of parts." It has commonly been held among scientists that the scientific method must be kept free from contact with human concerns. Many of them, however, would now agree with H. S. Fries that, while it is possible that concern for other than scientific purposes may prejudice scientific observation and analysis, it is just as possible that the refusal of science to be concerned with other purposes relevant to its activities may be an even greater prejudice.⁴¹ It is clear that the desire to discover new knowledge just for the sake of knowing is and will remain one of the prime motivating forces in research. Nevertheless, the idea that the only real knowledge is pure knowledge and free from all implication of practical consequence is rapidly going overboard.⁴² One may hold pure science in great respect and, at the same time, be well aware that its infer-

³⁹ Crowe, P. R., *op. cit.*, p. 10.

⁴⁰ *Nature*, Supplement, April 23, 1938, p. 723 ff.

⁴¹ Fries, H. S., "Method in Social Philosophy," *Jl. Social Philos.*, Vol. 3, 1937-1938, pp. 325-341.

⁴² Fries, H. S., "Social Science and Human Values," *Jl. Social Philos.*, Vol. 3, 1937-38, pp. 54-58.

ences rest upon postulates. One may yield it great admiration for its accomplishments without believing that scientific understanding is its only goal. He may hold, and still be in good company, that science can be at the same time autonomous and aware of social needs. He may indeed go so far as to agree with Fries that "If science will not be critically practical, its uncritical practice will likely be its own undoing."

What bearing, one may inquire, does a broadening opinion relative to the objectives and allegiances of science in general have upon the validity of the methods and practice of regional geography? It is, as it seems to me, that regional geography stands in a position that is significant with respect to science, society and these changing trends of thought. Many writers on the relations of science to society have indicated that the need of the future is not so much a change in the methods of science as it is better facilities for the correlation of the findings of all the sciences and a more satisfactory synthetic presentation of their great importance with respect to social development. It has been shown already that while the method of regional geography is basically analytical and descriptive, it has also a pronounced correlative function, and its method of presentation is consciously synthetic.

Moreover, chorologic method seems to offer one practical means of approaching a highly complex association of physical and cultural features which may be reduced to reasonably manageable proportions areally as well as topically. It is fully appreciated that other disciplines also are concerned with regions, but none so completely as geography with their correlative aspects. Within the field of cultural geography no method is more directly applicable to the social relations of science than that of chorology, because many social problems exist in regional complexes and must be solved in reference to their regional associations. I have no intention to maintain that the chorologist should become regional planner. I hope he may remain an investigator. However, it is essential that in some science there should be developed an understanding of regional qualities, regional differences and regional interdependence, so precise and so rational that the regional planner can not escape their applicability to his task; so clear that the legislator and the man of the street will be aware of their meaning. These understandings are necessary if regional planning is to be generated safely out of the local need for it rather than superimposed by authority. But, whether or not the geographer is to be personally involved in regional planning, it may be safely held that different sciences have different degrees of applicability to the solution of social problems. In his comment on the social relations of science, H. G. Wells says: "The essential difficulty in working out any special social functions for scientific men lies in the fact that, so far as the

great majority of sciences go, the individual worker has no special aptitude for social organization. His time, his mental energy he owes to his special work. But this is less true of certain sciences than of others. It is less true, for example, of biology than of astronomy. It is less true of anthropology and psychology than of invertebrate anatomy. In the case of human ecology and social psychology, the man of science works in a field whose generalizations are almost immediately applicable to social organization."⁴³ If Wells' contention holds true for geography defined as human ecology, it would seem even more applicable to the scientific study of regions.

CHOROLOGICAL OBJECTIVES

Certain methods and objectives have been imputed to chorology which it may be to its advantage to disavow. Regional geographers do not maintain that *all* workers under geographical discipline should perform as regionalists or even that they themselves should always treat of the regional entity in its totality. The opinion has been stated earlier that there are many problems in the realms of landforms, climate, settlement forms and other natural and cultural elements which require topical investigation for distinctly geographic ends. The chorologists do suggest, however, that those who choose to investigate individual geographic elements, either extensively or intensively, do so with a realization that their findings still are or should be made amenable to use within a regional framework.

The chorologists have no desire to produce a succession of dry and encyclopaedic inventories of the contents of an infinity of minute areas. Doubtless there will be many studies of that class to encumber the libraries of the land. But such an accumulation can hardly become a greater problem than, for example, the mounting flood of geological reports on stratigraphic and hydrographic minutiae. Truly, when one views such periodical catalogues of scientific research as the *Experiment Station Record* or, even in our own field, *Bibliographie Géographique*, he marvels at the continued hospitality of libraries.

What objectives may properly be attributed to American regional geographers? I have asked for no mandate to speak for them, but it appears to me that there are certain purposes to which most of them would adhere. They would select for geographic study areas in which there are unanswered questions growing out of a peculiar areal association of features, natural with natural, cultural with cultural, or cultural with natural. They would attempt to provide new knowledge and penetrating insights concerning these areal associations by objective and critical methods. They would desire that the discovery of new knowledge, the creation of deeper understand-

⁴³ *Nature*, Supplement, April 23, 1938, p. 725.

ings, and the solution of problems in regional association might provide a basis for a more adequate comprehension of geographical changes and trends. Such a comprehension, one would hope for, as might be useful in the development of a sound social philosophy, particularly as it relates to the occupancy and use of land, and perhaps more broadly in the attainment of humanistic objectives. These propositions will bear further examination.

In selecting for study such areas as present problems, the investigator may be aware of questions of at least two classes. Each has its academic phase, but it may well be a practical problem also. There are those which reside in the existing, the static, regional association of features. Reasons for the present nature of the cultural distributions, the human occupation and use of area, seldom are obvious. The search for causes underlying the associative relations of existing forms leads in many directions. There are also those problems inherent in the nature and processes of geographic change, both past and current. The pursuit of such studies involves inquiry into the nature of the regional features of the past, the tracing of their evolutionary trends, and the discovery of the geographically important conditions attending the changes involved. The regions selected for these studies might have qualities that are unique among regions or they might prove to be representative (hardly typical) of a group of regions. But neither a supposed uniqueness nor representativeness may be considered of themselves the only reasons for chorologic selection. The possibility of an ultimate social utility cannot reasonably be excluded from the consideration.

In his attempt to bring new knowledge to light the regionalist must base his explanatory descriptions upon both primary and secondary data. The former he will gather principally through field observations by the application of geographic techniques now developed or developing. The inclusiveness of their detail will be measured by the nature and extent of the area investigated, the character of the questions it raises, and the instrumental facilities at the disposal of the investigator. This procedure is that followed in such areal sciences as stratigraphic geology and is defensible in any science. Secondary data he may or may not have in abundance. Areas that have been topographically, meteorologically, geologically, biologically and economically surveyed provide it. But that very abundance seems often to produce more of obscurity than of enlightenment from the standpoint of any clear social significance. It is a confusion of specializations until it has been analyzed and sorted in conformity with the requirements of a defensible purpose and the vital elements have been correlated and presented in a synthesis which is in accordance with that purpose.

To what justifiable social purpose can the methods of a science of regions be directed? It may be stated only in broad terms as humanism.

But one's inability to state a philosophical concept explicitly does not make it less real. Perhaps we may agree upon a humanistic doctrine which holds that men through the use of intelligence, directing the institutions of democratic government, can create for themselves a rational civilization.⁴⁴ It is the position of the regional geographers that their efforts to this end will be more effective if they follow the orderly and rational methods of science rather than the methods of the literary and pictorial arts. This, it hardly seems necessary to say, is because an objective which has rationality as its core can be more directly attained by methods as nearly rational as continual striving to make them than by the admittedly subjective or even impressionistic methods of art. It is not, in the main, within the province of the regional geographer to discover by his studies any rules for human behavior in the presence of given conditions of earth environment. It is, however, within his province to discover meaningful associations of regional features which otherwise would pass unnoticed to the detriment of human knowledge and the foundations of social progress. And, with more than a plausible optimism, he hopes that this knowledge may be of use to the regional planner and his kind. In any case, one can hardly escape the feeling that the suggestion recently made that the regional planner may well "pray for deliverance from the unasked attentions of the critical academic" chorologist⁴⁵ is on the same footing as a wish that one's physician would pray for deliverance from the attentions of the academic anatomist. In the present status of the relation between science and society it is doubtful wisdom to draw the line too sharply between a pure and autonomous scholarship and a scholarship with an intelligent social consciousness. Autonomous scientific scholarship does not lose its autonomy by choosing to investigate matters which lie at the roots of social problems. The physical sciences must indeed deal with subjects many of which are remote from social considerations, but the very term social science seems to imply the pursuit of knowledge with a social objective and to render its research more than others a public service. Cultural geography has openly taken its stand in the social field. Does the admission of an ultimate social objective appear to involve a trammeling of geographic research? It seems hardly likely, so long as the choice of direction for his research is made by the investigator from his own sense of responsibility and not at the behest of an impatient social authority; so long as he is left free, having made his choice of problem, to follow it wherever it may lead.

A statement of chorological objectives is easier to make than a program

⁴⁴ Reiser, O. L., *Philosophy and the Concepts of Modern Life*, New York, 1935, p. 311.

⁴⁵ Leighly, John, *op. cit.*, p. 129.

for their accomplishment. One of the inherent difficulties lies in the fact that the explanatory function of geography leads the regionalist's inquiry in so many directions that he must be reasonably conversant with the geographically significant facts, if not with the methods, of many fields of science. In this he differs from workers in other sciences not much in principle but perhaps somewhat in degree. Strabo and even his predecessors were aware of this requirement for he says "there is need of encyclopaedic learning for the study of geography, as many men have already stated." That fact has been the despair of all thoughtful geographers, and it goes without saying that few if any in the profession are learned enough. But, working with such equipment as he has, the regional geographer finds his middle-ground position, between the alternatives of general geography and microgeography, desirable and defensible. It is the one in which he may deal by defensibly scientific means with an areal complex of manageable proportions. It is the one in which he may hope to bring to knowledge new facts of a scientific order which belong in a domain not treated specifically by other sciences. However, no regionalist, to my knowledge, feels satisfied with current chorological writings. That is not because he feels them inherently unscientific. He would not be satisfied were they presented as examples of artistic method.

If then the method of chorology has scientific quality and social value, but its current results are not satisfactory, wherein does the deficiency lie? I suggest that we may look for it in the immaturity of most regional studies. They are too often aridly descriptive and lacking in penetration. Too few contribute much to the solution of vexing problems that only an understanding of the complexities of many interrelated features rather than of the individual regional elements ever can give. The renaissance of regional method is comparatively recent. There have been many fields to plow, and too often the plowing has been hurried and shallow. There has been also the need for a hasty closing of wide gaps in the broader aspects of regional geography for use in teaching. These conditions have not existed in the same degree with respect to some of the topical studies in geography, especially those which have employed the techniques of physical geology. In those fields are men whose present publications represent the conclusions of many years of close attention to a limited range of features. In American chorology there has perhaps been too much also of opportunism in research, too much of a skimming of the cream of the more clearly given from a region and then its abandonment for another area.

What can be done for chorology that has not already been done? The implication of my previous comments makes my opinion obvious. The mature study in regional geography well may be the work of a lifetime. It

may or may not begin with a general study in reconnaissance. It may proceed by studies of the important elements in sequence and in some reasonable order, since it is obvious that they can not all be studied at once. But the chorologically important thing is that the same mind should attempt to understand them all and to grasp the elusive connections between them. To state that the complex facts of a region are too diverse to be understood by any one individual may be true, but it has no more practical importance than to say that the economic, social and political issues in that same area are too complex to be met by a political administrator. Regions must be administered and the wise administrator must steer a course between the poor alternatives of irrational activity and rational inactivity.

Whether or not the dream of the chorologists with respect to a science of regions is a vain dream, is not likely to be settled on logistic grounds. The chorological position may be logically attacked and logically defended, but the history of science furnishes many illustrations of systems of closely reasoned logic which have broken down because of vulnerable premises. We may agree with Vallaux that correct logic does not suffice to make a science fruitful but, if pressed too far, tends to sterilize research.⁴⁶ Neither does it seem likely that geography will be justified as a field of scholarly endeavor either by the detail of its amassed facts or the perfection of its artistic concepts alone. It seems probable that it will be justified quite as much by its scholarly contributions to the development of a wholesome social philosophy. Such contributions may depend, in the end, more upon the qualities of the men who enter the profession of geography than upon the form of geographical discipline by which they proceed. However, as this writing has attempted to show, the regional approach has qualities that permit of scientific attainment and, at the same time, promote the development of socially valuable ideas. It is safe to say that the able young geographer may face confidently a future of satisfying scholarship under a chorologic discipline if he is willing and able to make the necessary investment. He may or may not confine his researches to regional study. But in so far as he hopes to make contributions in that direction there are, I think, certain things he must do. He must select a region which is, above all else, to be the field of his lifelong study. He may define it, subject to revision, upon almost any of the various bases that have been proposed. Its extent must be determined by the nature of the problems it presents. He must spend his years at the careful analysis of its concomitant forms, its patterns and its functions, both past and present. He must collaborate to the fullest extent with his colleagues in contributory fields of science for the enrichment of his regional knowledge. He must invest greatly of time

⁴⁶ Vallaux, C., *op. cit.*, p. 29.

and effort to know his region from the inside, its people and their ideas as well as its material forms and functional processes. He must submit to his colleagues from time to time the results of his analyses either in topical series or in partial synthesis of such features as may have a bearing upon critical regional conditions. Only after a long and rich experience and perhaps with mature years may he expect to speak concerning his region with what is by common recognition, both in and out of the geographic profession, an authority beyond question.

*University of Wisconsin,
December, 1938.*

The Weather Element in the Hawaiian Climate*

STEPHEN B. JONES

That the Hawaiian climate is dominated by trade winds and orographic rainfall is a more than twice told tale. The averages with which climate is usually described fully bear out this simplicity. Northeasterly and easterly winds blow more than eighty per cent of the time in the lower levels of the free air (Figure 1).¹ Temperatures are so uniform that records are broken

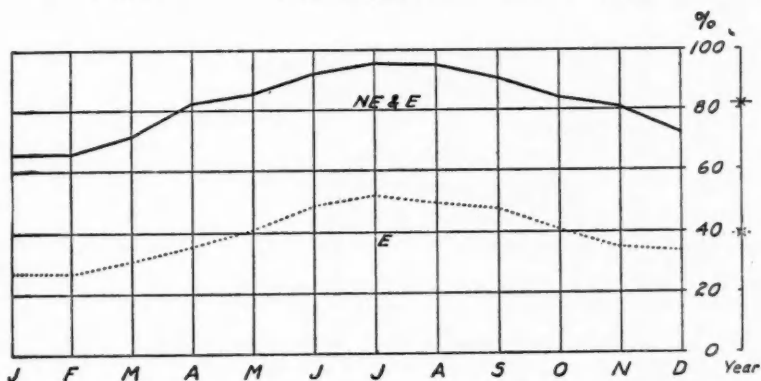


FIG. 1.—Frequency of northeast and east winds at Honolulu (U.S.W.B. station).

by a tenth of a Fahrenheit degree. Isohyets show a general pattern obviously related to relief. Windward and leeward stations differ profoundly

*The writer is greatly indebted to the staffs of the United States Weather Bureau, Honolulu, and the Fleet Air Base, Pearl Harbor, for information embodied in this paper. He wishes to thank Robert G. Stone of Blue Hill Observatory for invaluable constructive suggestions.

Some of the data on which the study is based are given in metric, others in English units. For uniformity all measurements used in the paper are expressed in the metric system.

¹E. A. Beals, "Free-air Winds over Honolulu and Guam," *Monthly Weather Review*, Vol. 55, 1927, pp. 222-225.

A. Thomson, "Upper-air Currents at Honolulu, Territory of Hawaii," *ibid.*, Vol. 56, 1928, pp. 496-498.

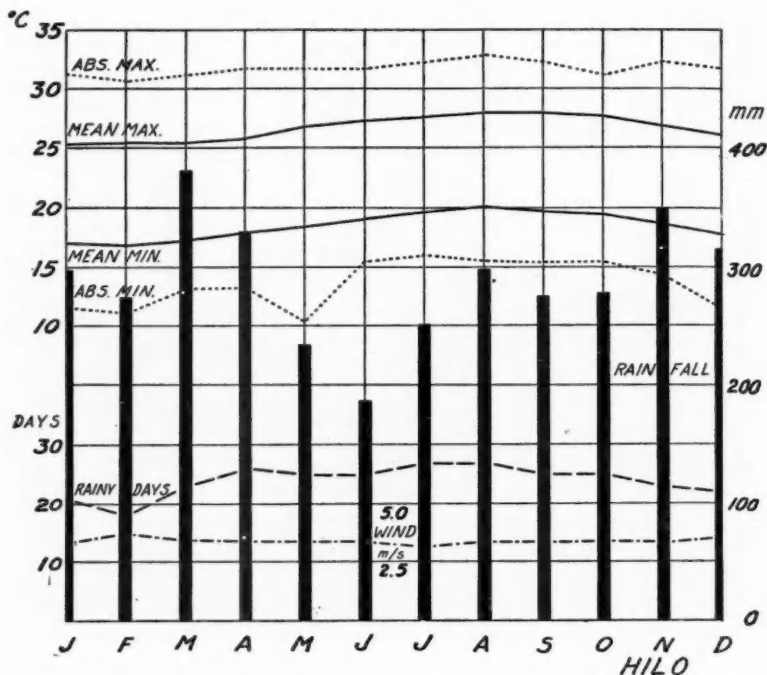


FIG. 2.—Climatic elements for a windward station, Hilo, Hawaii. (See Figure 12 for location.)

in precipitation and noticeably in temperature (Figures 2 and 3). But averages by no means tell the whole story.² Minor changes of weather are frequent. Though ignored by travellers used to middle latitude winters, they present problems as obscure as those of stormier climes.

Weather changes in the Hawaiian Islands are of several types. The most pronounced are due to cyclonic storms, chiefly in the winter half-year, but the trades themselves vary greatly in velocity and may bring brilliant sunshine or torrential rain. When rainless trade wind days follow one another in steady procession, it may indeed seem as if the islands had climate but no weather. Such spells may last for a month or more on lee coasts in summer. With a persistent breeze and moderate humidity, the temperature in the shade stands so near the comfort level that individuals disagree as to whether the days are warm or cool. Occupation, clothing habits, housing—

² Cf. S. S. Visser, "Variability vs. Uniformity in the Tropics," *Scientific Monthly*, Vol. 15, 1922, pp. 22-35.

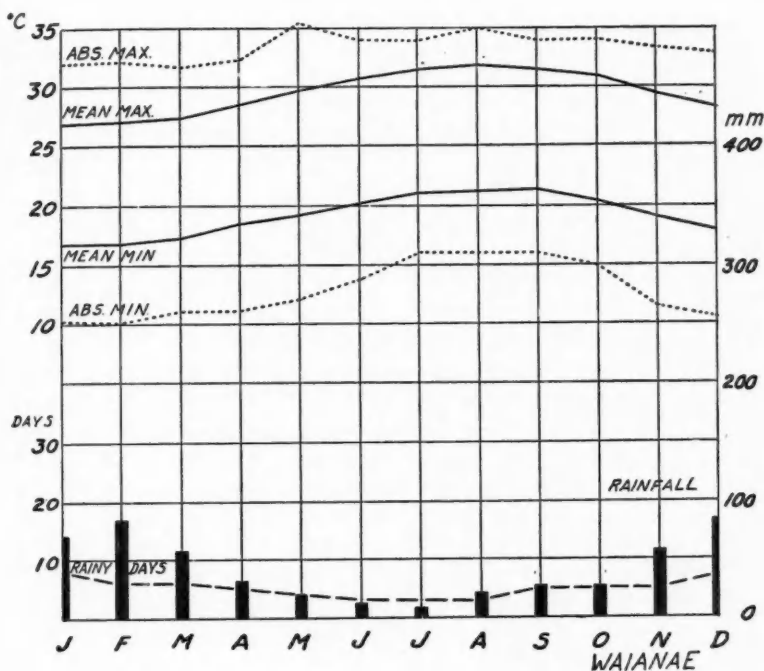


FIG. 3.—Climatic elements for a leeward station, Waianae, Oahu. No wind data are available. (See Figure 18 for location.)

the presence or absence of a window, a shade tree, or an undershirt—may tip the scale. The daily range is moderate, but thinly-clad people in unheated houses are sensitive to the drop between afternoon and evening. The most impressive changes in trade wind weather are in precipitation. Fluctuations may take place from hour to hour, day to day, and place to place. Residents become inured to the vagaries, for the rain is usually warm and intermittent. Umbrellas are little in evidence and overshoes almost unknown.

TRADE WIND AIR MASSES

The immediate source of the trade winds is, of course, the North Pacific subtropical anticyclone—a region of variable winds rather than persistent calm.³ There, the ocean surface is five or six degrees, Centigrade, cooler

³ E. A. Beals, "The Northeast Trade Winds of the Pacific," *Monthly Weather Review*, Vol. 55, 1927, p. 216.

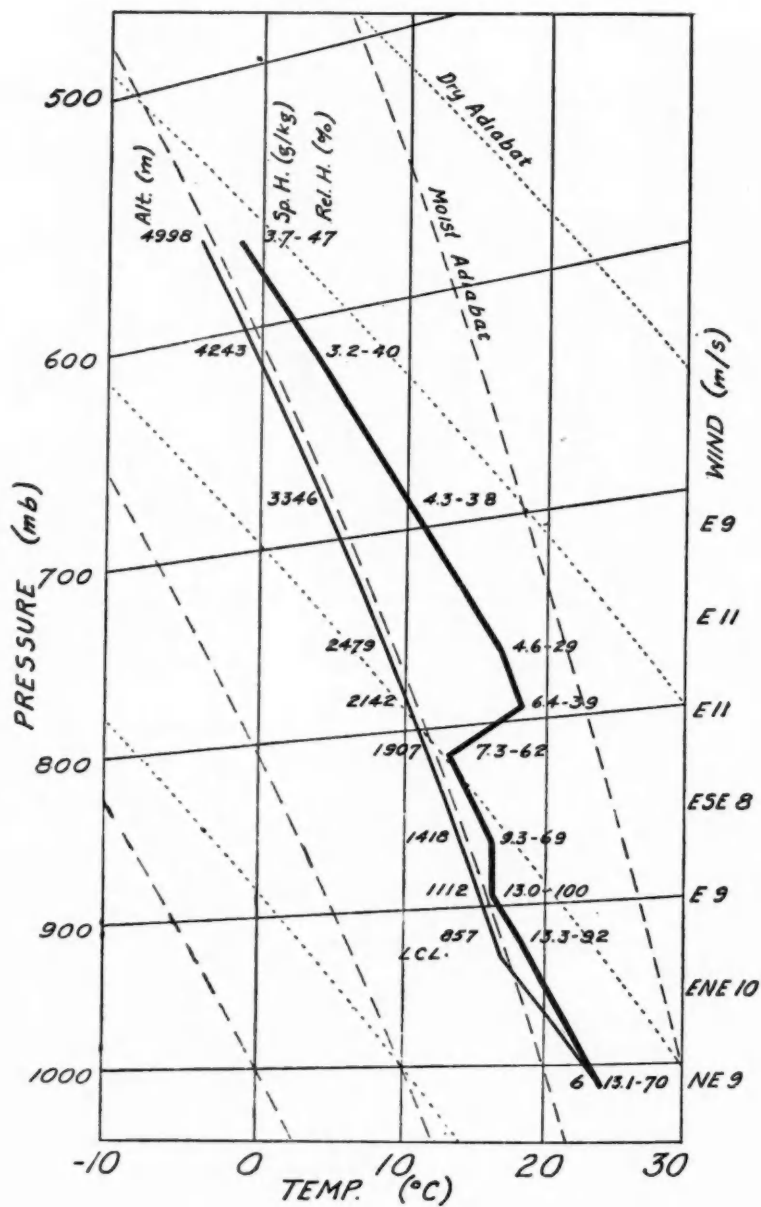


FIG. 4.—Aerogram for a trade wind day, showing isothermal layer (1112 to 1418 meters) and temperature inversion (1907 to 2142 meters). In spite of these impediments to convection, more than a millimeter of rain fell at Honolulu (U.S.W.B. station.) The diagram is drawn on a simplification of the Refsdal chart. The heavy line gives observed temperatures and pressures from the morning flight at Pearl Harbor. The light line indicates the theoretical behavior of lifted air. The area between the lines represents energy. In this case, the energy is entirely negative (to the left of the observed curve), tending to oppose convection. "LCL" indicates lifting condensation level, the level of cloud formation on windward slopes. Altitudes and humidities at significant points are given on the diagram. Wind directions and velocities at 500 meter intervals, from the morning pilot balloon sounding, are given in the right margin. The isobars, drawn straight, are portions of long curves, concave upwards. (July 31, 1937.)

than the surface about the Hawaiian Islands.⁴ Heat and water vapor are added to the lower part of the southward moving air. Ordinarily the instability so produced is not very great by the time the Hawaiian Islands are reached. The frequent presence of isothermal layers and of inversions further limits convection (Figure 4).⁵ Thus the scattered cumulus clouds, typical of oceanic trade winds, are normally of shallow depth and give little or no rain. Precipitation from such trade wind masses depends upon orographic lifting. Saturation usually is produced by a lifting of less than one thousand meters. On smooth mountains, rainfall decreases above that height, but funnel-like valleys may raise the level of maximum precipitation to fifteen hundred meters or more.⁶ The mountain clouds, though perhaps cumulo in texture, do not pile up to great heights. The most stable trade wind air masses (Figure 5) give lenticular clouds which fit like saddles over the ranges.⁷ From the mountain clouds, rain is blown to leeward, often for three or more kilometers. Evaporated to mist-like drops, this rain is the "liquid sunshine" of Honolulu parlance.

If the temperature lapse rate on a given day is such that lifted air is

⁴ G. Schott, *Geographie des Indischen und Stillen Ozeans*, Hamburg, 1935, Plates XX-XXIII.

⁵ An inversion, usually below 2000 meters, is a persistent feature of the Atlantic trade winds. H. von Ficker, "Die Passatinversion," *Veröffentlichungen des Meteorologischen Instituts der Universität Berlin*, Band I, 1936, Heft 4.

⁶ As on Waialeale, Kauai, one of the rainiest spots on the globe. J. F. Voorhees, "Some Factors Controlling Rainfall and Rainfall Distribution in Hawaii" (abstract), *Proceedings Hawaiian Academy of Science*, Bernice P. Bishop Museum Special Publication 21, Honolulu, 1933, pp. 6-7.

H. E. Gregory and C. K. Wentworth, "General Features and Glacial Geology of Mauna Kea, Hawaii," *Bulletin of the Geological Society of America*, Vol. 48, 1937, p. 1728.

⁷ Cf. C. F. Talman, "The 'Tablecloth' of Table Mountain," *Monthly Weather Review*, Vol. 49, 1921, p. 192.

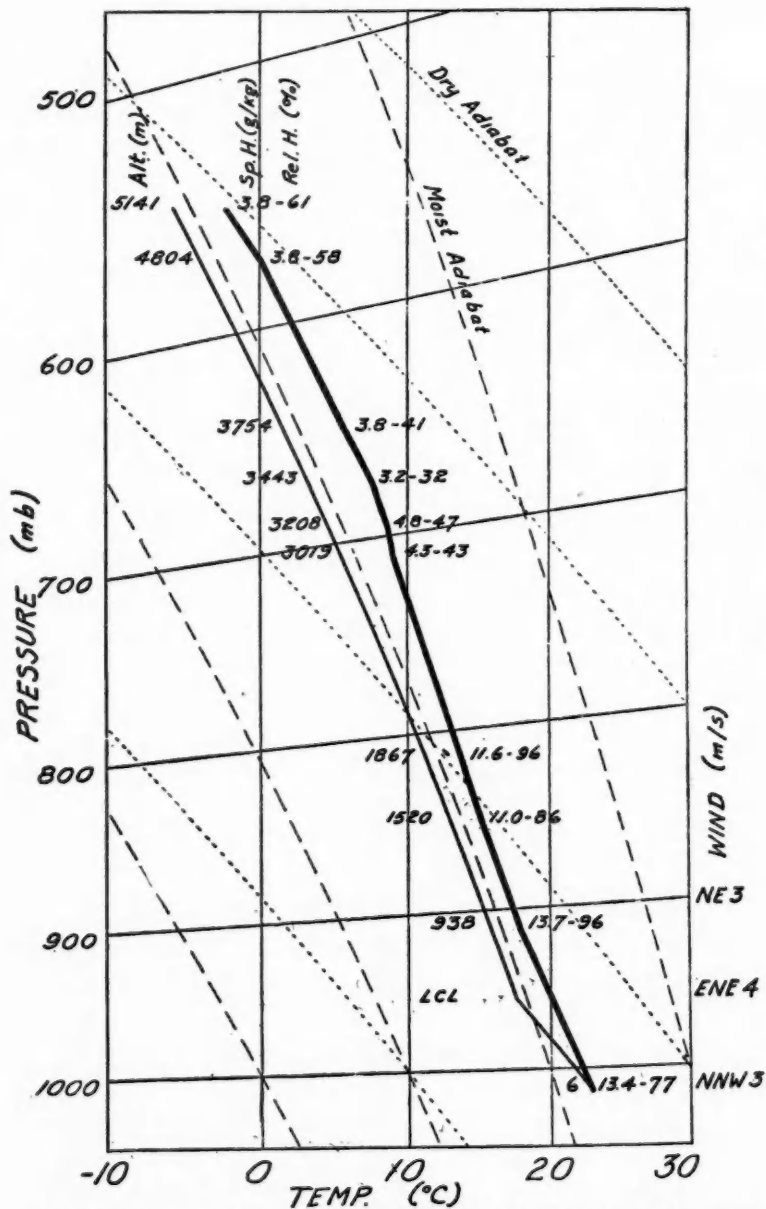


FIG. 5.—Aerogram for an exceptionally stable trade wind day, with a very uniform lapse rate. This day was marked by saddle-like clouds over the mountains windward from Honolulu. (May 6, 1937.)

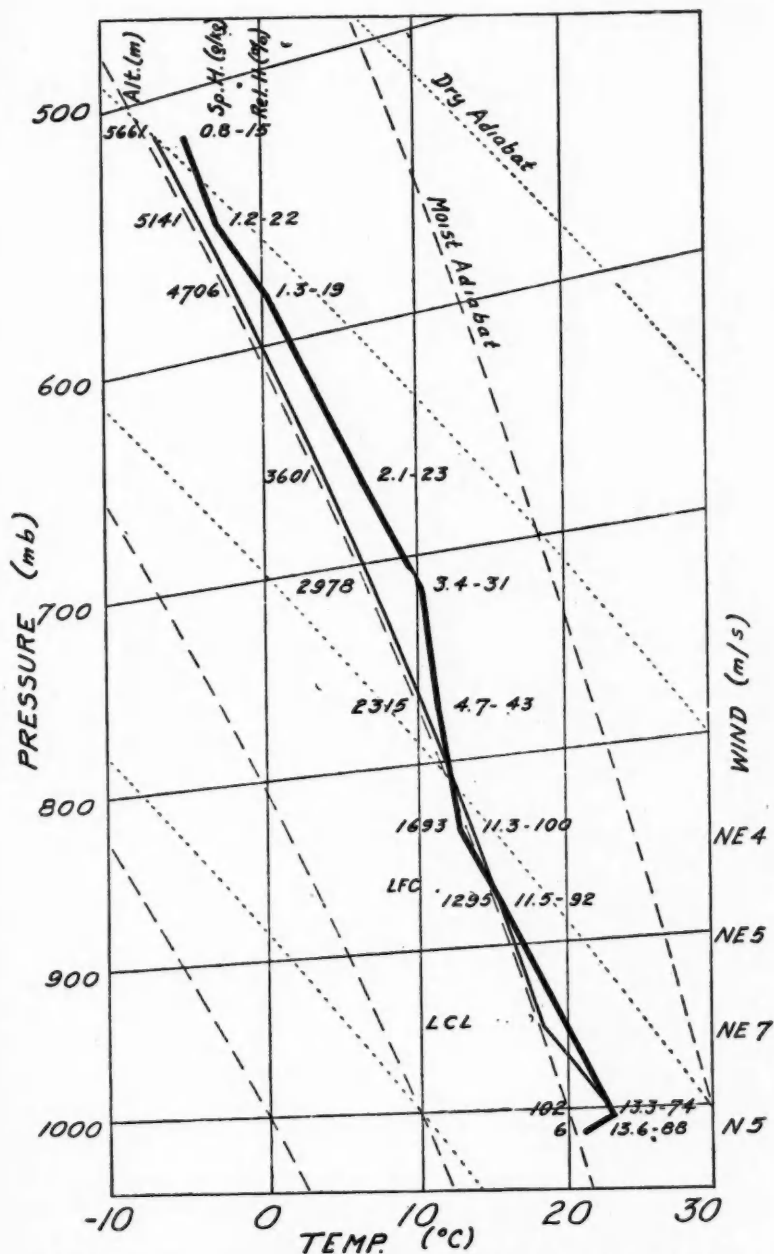


FIG. 6.—Aerogram for a trade wind day with moderate instability. "LFC" indicates level of free convection. A small positive energy area (to right of observed curve) is present above 1300 meters, but the nearly isothermal conditions from 1693 to 2978 meters checked convection. Precipitation at Honolulu (U.S.W.B. station): Trace. (November 21, 1937.)

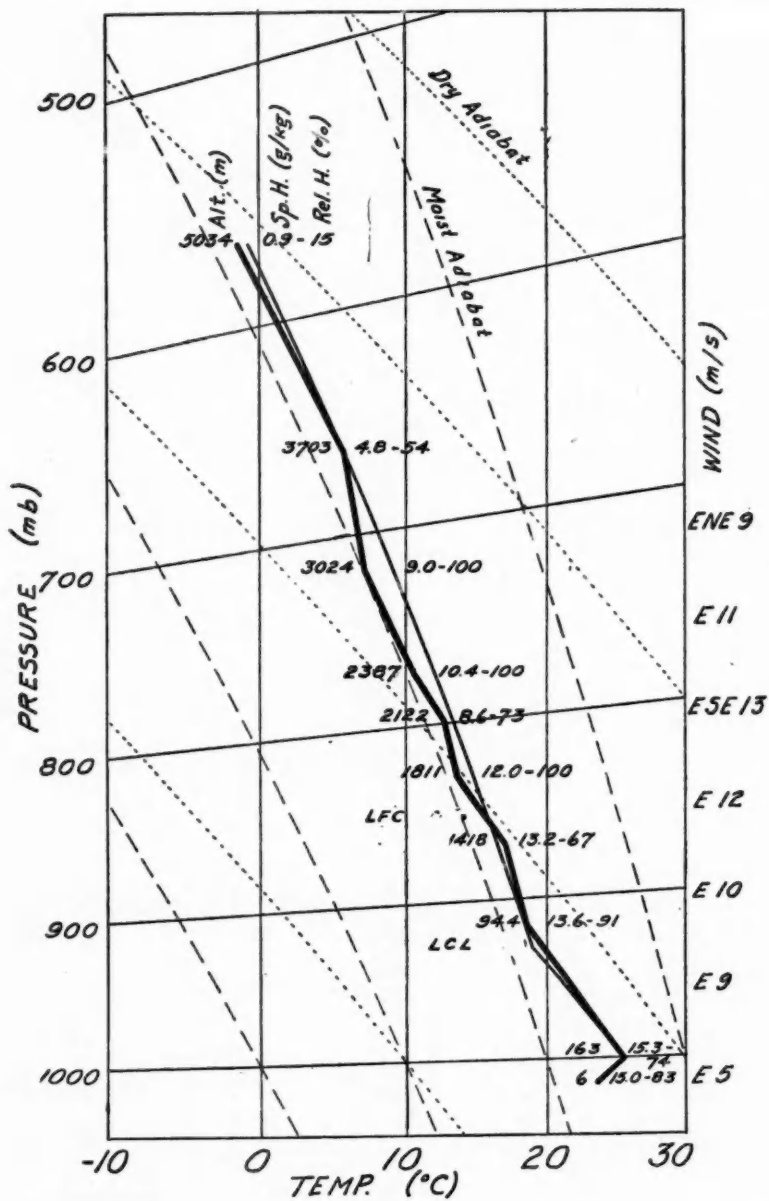


FIG. 7.—Aerogram for a trade wind day showing marked instability. Note that cloud formation (as shown by relative humidities) extends to much higher levels than on preceding aerograms. Precipitation at Honolulu: 2.5 mm. (November 6, 1937.)

warmer than its surroundings, orographic lifting may initiate free convection. When positive convective energy is slight (Figure 6), such showers, though perhaps intense in the mountains, quickly die away to leeward (Figure 8). The frequent occurrence of such conditions justifies the trite but

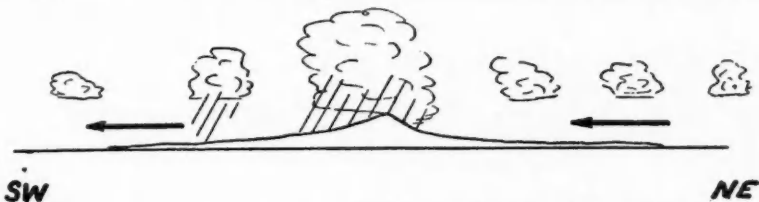


FIG. 8.—Schematic cross-section of the island of Oahu, windward from Honolulu, on a trade wind day of moderate instability. The mountains are approximately 1000 meters in altitude; the distance between shores, fifteen kilometers.

indispensable forecast: "Scattered showers in the uplands." Greater amounts of positive energy (Figure 7) lead to heavy showers, most intense over the mountains but general over the oceans and received by all but the most protected leeward stations.

It will be observed that there is little difference between the most stable and most unstable trade wind air in surface temperature and humidity. Oceanic uniformity has been impressed on the lower layers. The critical differences are aloft. Due to the paucity of synoptic data for the Pacific, it is not always possible to trace air masses with certainty from their sources. It seems probable that extreme instability, with cold, dry air aloft, indicates rapid transportation from a polar source, while a more even distribution of temperature and water vapor suggests a long journey over warm seas. Thus, heavy showers can come from air masses which are drier, as a whole, than stable, rainless masses from warm sources.

Due to the small diurnal range of water temperatures, air over the ocean often is more stable in the day than at night, when radiation aloft may produce top-heaviness. The Hawaiian Islands have a marked nocturnal rainfall maximum (Figure 9), particularly in summer when cyclonic rain is rare.⁸ For practical purposes, nocturnal rain is convenient. The coolness

⁸ E. H. Loveridge, "Diurnal Variations of Precipitation at Honolulu, Hawaii." *Monthly Weather Review*, Vol. 52, 1924, pp. 584-585.

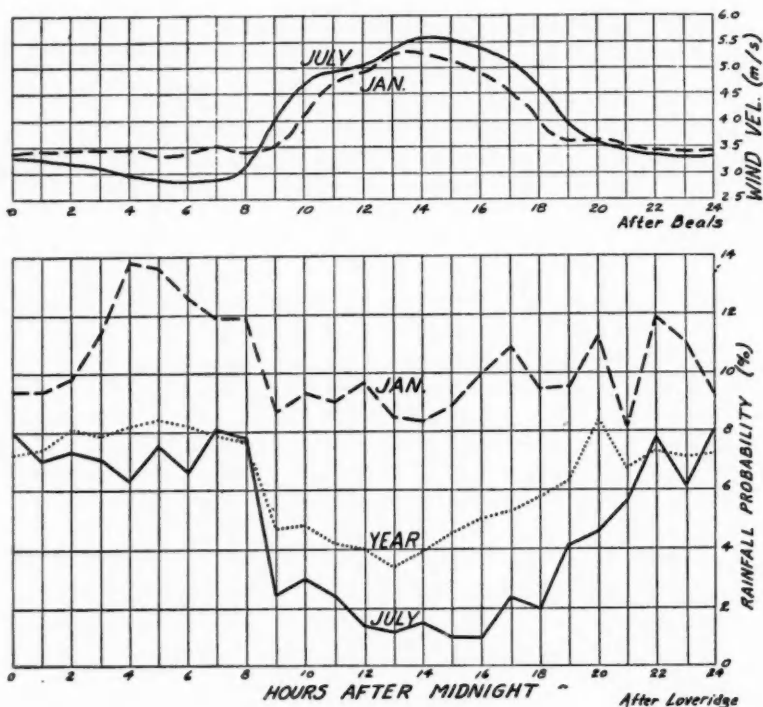


FIG. 9.—Diurnal variation of wind velocity and rainfall probability, Honolulu (U.S.W.B. station). After Beals, *Monthly Weather Review*, Vol. 55, 1927, p. 221, and Loveridge, *ibid.*, Vol. 52, 1924, p. 584.

that follows an afternoon thundershower is not often an Hawaiian delight, but the sultriness that precedes one is not often an Hawaiian torment. Evening strolls may be interrupted by sudden showers.

Given a good breeze, of force 3 or 4, Beaufort, the islands, except the largest, are little more than ships in the ocean for other than orographic effects upon weather. On calm days, insolation on and radiation from the islands become more significant. The temperature and humidity ranges are above normal (Figures 10 and 11). On lee coasts, a southerly sea breeze may spring up, clouds gather, and perhaps a little rain fall. The succeeding night may be clear, with a cool mountain breeze, a surface inversion, and

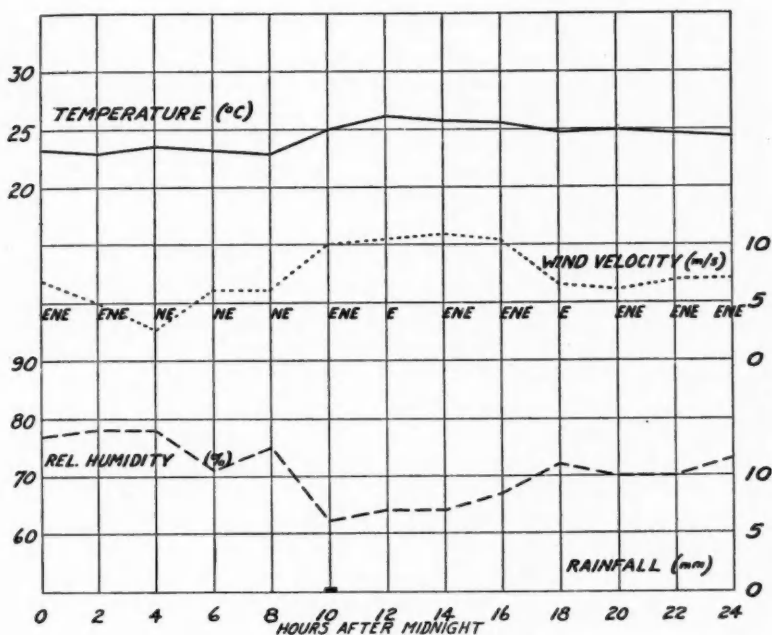


FIG. 10.—Bi-hourly data for a trade wind day, Fleet Air Base, Pearl Harbor. (November 6, 1937). A showery day with very spotty rainfall (cf. aerogram, Figure 7). The rainfall at Honolulu (U.S.W.B. station) was ten times as great, and fell at different hours.

heavy dew. It is within the bounds of possibility that the highest and lowest temperatures of an entire year come within twenty-four hours of calm weather. The high mountains of the largest island, Hawaii, shut off even the strongest trade winds from the Kona district of its southwestern coast (Figure 12). Here, land and sea breezes occur almost daily. The rainfall maximum comes in summer, in afternoon and evening convectional showers.⁹

⁹ A. J. Henry, "Hawaiian Rainfall," *Monthly Weather Review*, Vol. 53, 1925, pp. 13-14.

J. W. Coulter, "The Island of Hawaii," *Journal of Geography*, Vol. 31, 1932, p. 230. [cont.]

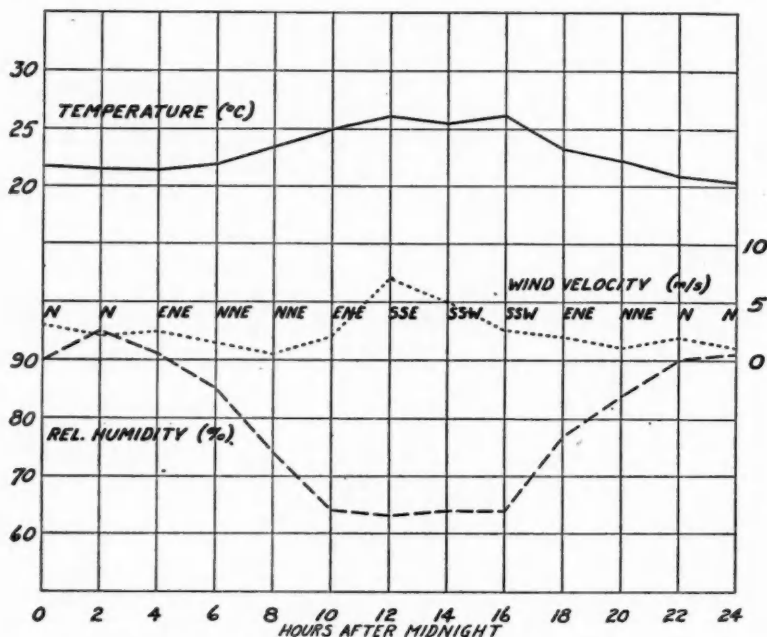


FIG. 11.—Bi-hourly data for a day of rainless "kona weather," Pearl Harbor. (December 18, 1937.) The greater range of temperature and humidity, compared with Figure 10, is apparent. Land and sea breezes are shown.

FRONTAL WEATHER

It is atmospheric fronts that give the islands their most changeable weather. Most of the fronts affecting the islands are related, at least indirectly, to extratropical cyclones over the North Pacific.¹⁰ They are, there-

H. A. Powers, J. C. Ripperton, and Y. B. Goto, "Survey of the Physical Features that Affect the Agriculture of the Kona District of Hawaii," *Hawaii Agricultural Experiment Station Bulletin* 66, Honolulu, 1932, pp. 10-12.

¹⁰This statement is based on examination of a large number of weather maps at the Fleet Air Base, Pearl Harbor. No weather maps are reproduced in this paper because of the difficulty of definitively locating fronts in the central Pacific, where ship reports are few and irregular and upper air data on temperature and humidity are available only for Pearl Harbor. For the ocean north of the Hawaiian Islands, H. R. Byers has published a valuable series of analyzed maps ("The Air Masses of the North Pacific," *Bulletin of the Scripps Institution of Oceanography*, Technical Series, Vol. 3, 1934, pp. 311-353).

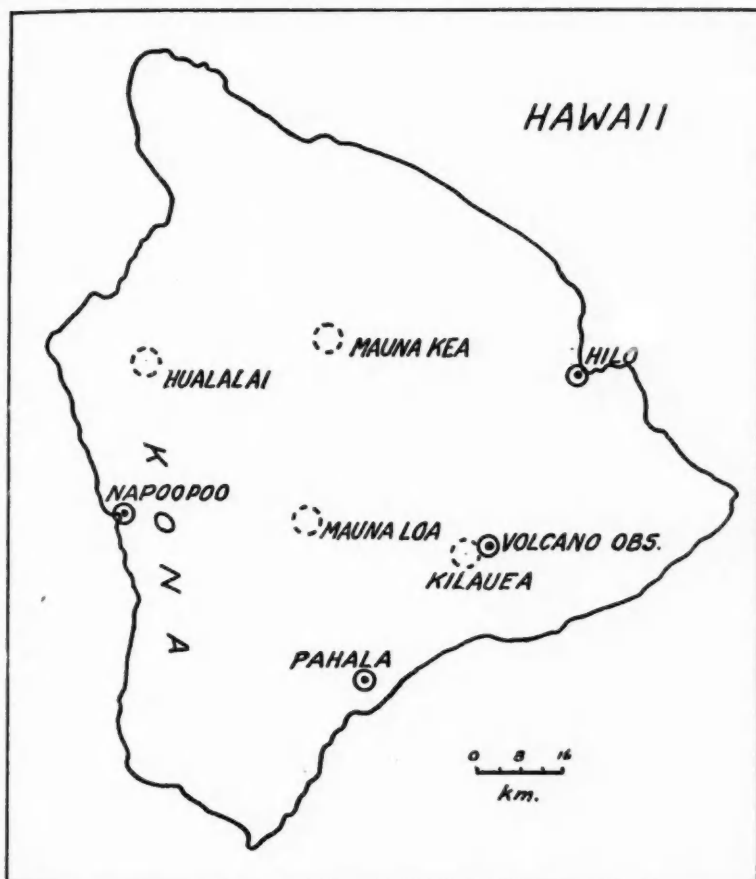


FIG. 12.—Location map to accompany Figure 14.

fore, most numerous and pronounced in the winter half-year. Consequently, temperature variability is usually greatest in winter (Figures 13 and 14) and most stations show a winter rainfall maximum. The winter maximum is more pronounced at coastal stations than in the mountains, for mountain stations receive a greater proportion of their rain from orographic lifting of the trades. Trade wind rain shows no such striking seasonal maximum (Figure 15).

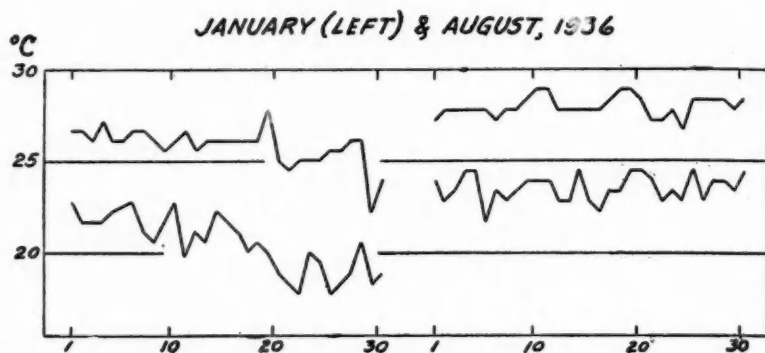


FIG. 13.—Daily maxima and minima for typical winter and summer months, Honolulu (U.S.W.B. station).

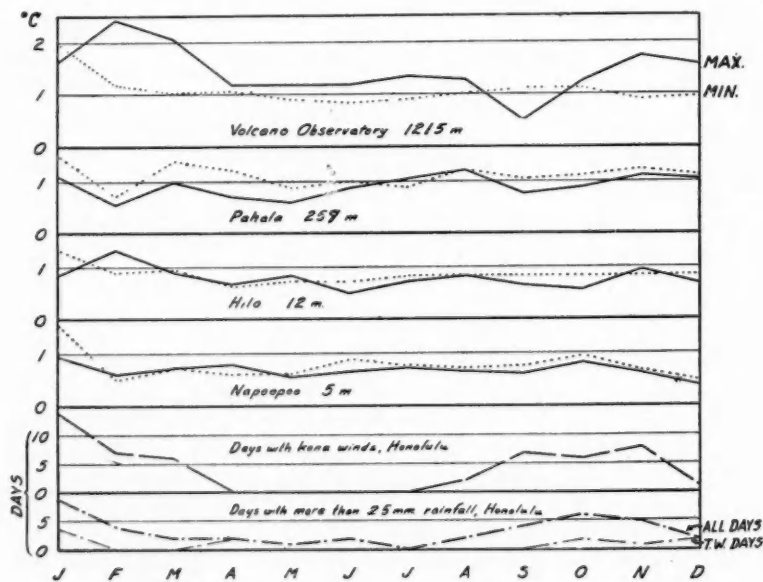


FIG. 14.—Interdiurnal variability of maximum and minimum temperatures at four stations on the island of Hawaii, 1930. (See Figure 12 for locations.) Increasing variability with altitude and distance from the sea, and, less regularly, in winter, is shown. Curves for cyclonic days and heavy rains (resulting from frontal passages or marked instability in trade winds) at Honolulu correlate approximately.

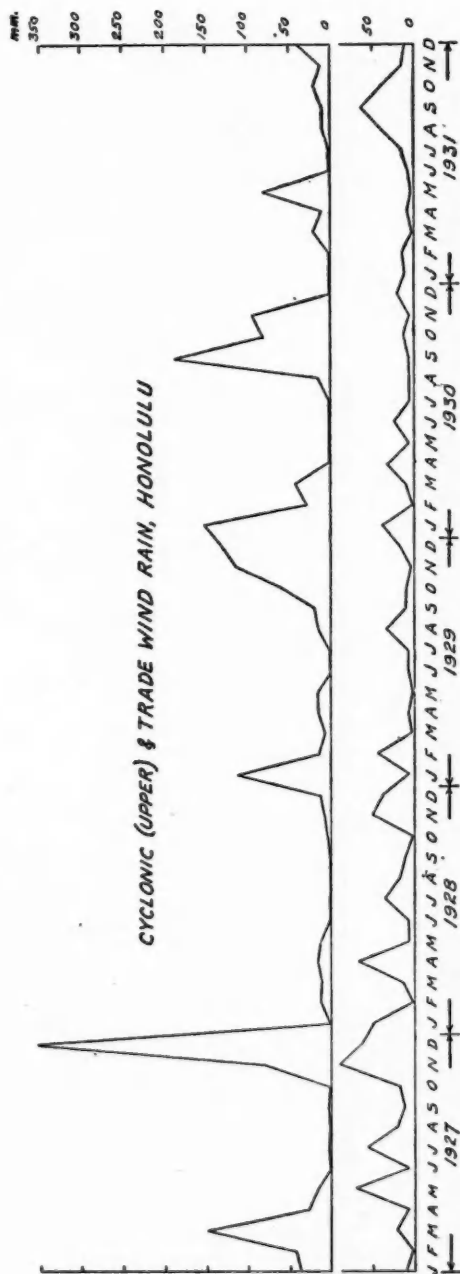


FIG. 15.—Cyclonic and trade wind rain at Honolulu (U.S.W.B. station), by months for a five-year period. The seasonal nature of cyclonic rain is apparent.

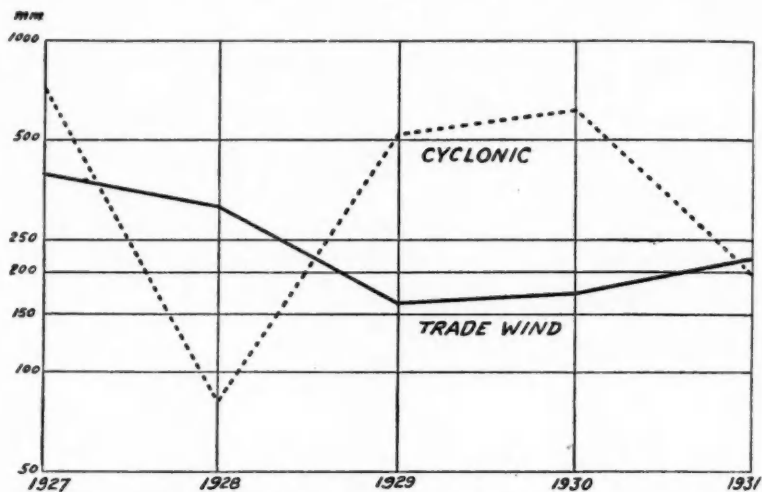
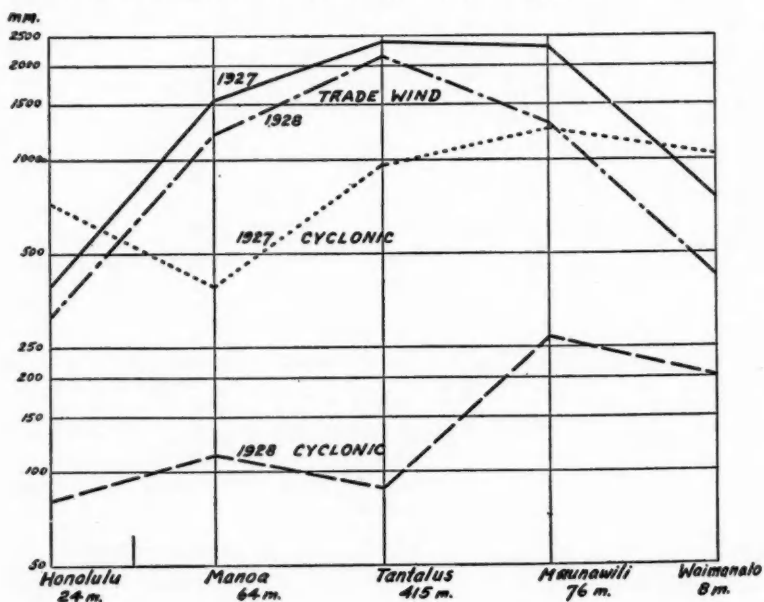


FIG. 16.—Cyclonic and trade wind rain at Honolulu for five year period, logarithmic scale. The greater variability of cyclonic rain is apparent.



Not only is the seasonal regime of Hawaiian rainfall largely determined by cyclonic activity, but so also are the month to month and year to year fluctuations (Figures 16 to 19). Stations at which the rain is dominantly orographic show much less variability than do those in the lowlands.¹¹ Stations on leeward coasts, except in Kona district, may receive most of the year's rainfall during a few cyclonic periods.

In local parlance, cyclonic activity gives the Hawaiian Islands "kona weather" and "kona storms." "Kona" is the Hawaiian word for leeward, or southwest. "Kona weather" describes periods of high humidity and light

FIG. 17.—Cyclonic and trade wind rain at five stations on Oahu (see Figure 18 for locations), for a wet year (1927) and a dry year (1928). The constancy of trade wind rain is shown; also its decrease with distance from the mountain crest. The relatively low mountains of Oahu permit considerable carry-over of both trade wind and cyclonic rain.

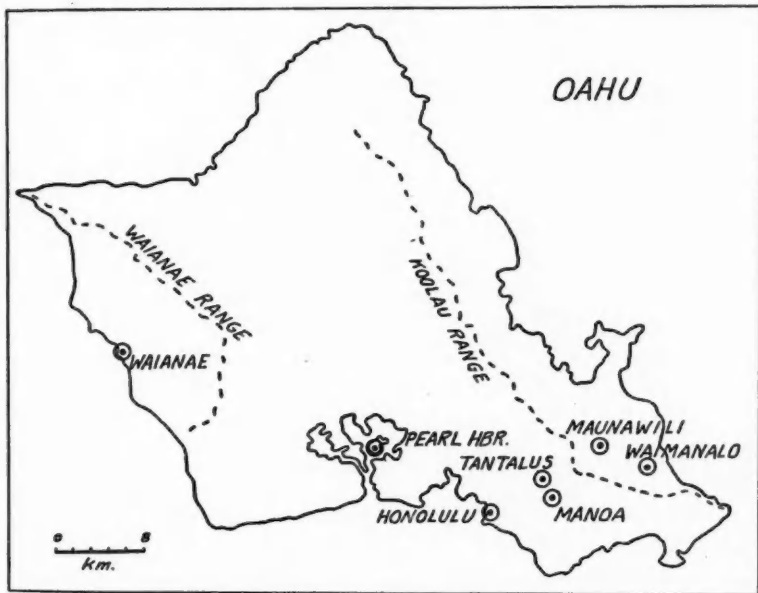


FIG. 18.—Location map to accompany Figure 17.

¹¹ W. T. Nakamura, "A Study of the Variation in Annual Rainfall of Oahu Island (Hawaiian Islands) Based on the Law of Probabilities," *Monthly Weather Review*, Vol. 61, 1933, pp. 354-360.

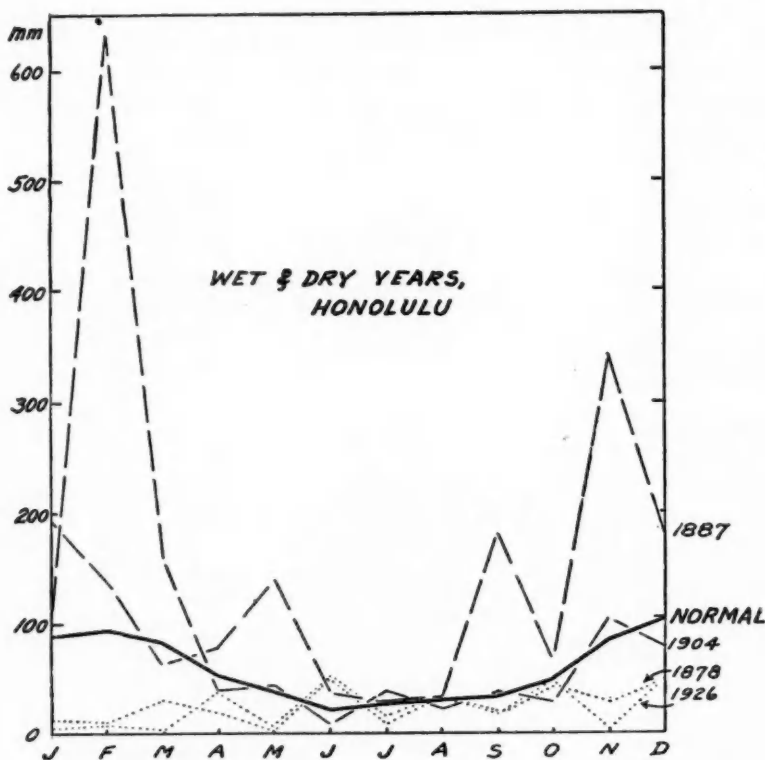
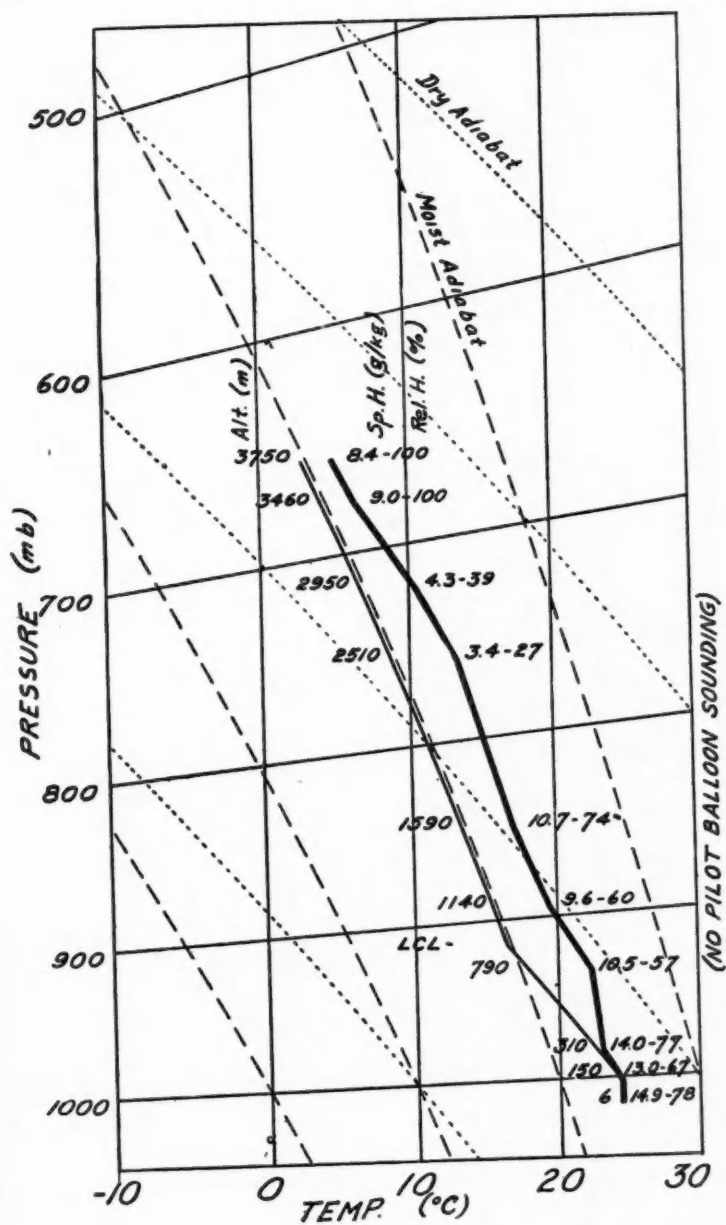


FIG. 19.—Monthly rainfalls for the two wettest and two driest years recorded at Honolulu. The variation is almost entirely in the winter rainfall.

southerly winds—the most oppressive weather the islands experience. The common statement that kona weather is a reversal of trade wind weather is much too simple, though spells not unlike reversed trades occasionally occur, when westerly winds bring old polar air from over the western Pacific. Ordinarily the vertical distribution of temperature and water vapor is distinctive (Figure 20). Since kona air masses usually come from equatorial seas warmer than those about the islands, cooling of the lower part

FIG. 20.—Aerogram during a kona storm. In comparison with trade wind aerograms (Figures 4 to 7), the lapse rate in the lower levels is more stable. The flight penetrated a front at 3460 meters, as indicated by the sudden increase in humidity. (December 12, 1937.)



by three or four degrees, Centigrade, raises the relative humidity and gives a more stable lapse rate, which slows down upward dispersion of moisture by convection. Kona weather is most unpleasant in autumn, when temperatures remain near summer levels.

Kona winds, of themselves, are not necessarily rain-bringing, but they are usually associated with rain-producing fronts. If the fronts bring brisk winds and heavy precipitation, they are "kona storms."¹² Despite high relative humidities, some kona storms are cool and invigorating, the wind, the cloud cover, the rain, and the descent of cool air behind cold fronts giving moderate surface temperatures (Figure 21).

Kona weather is usually of short duration, but such spells may follow

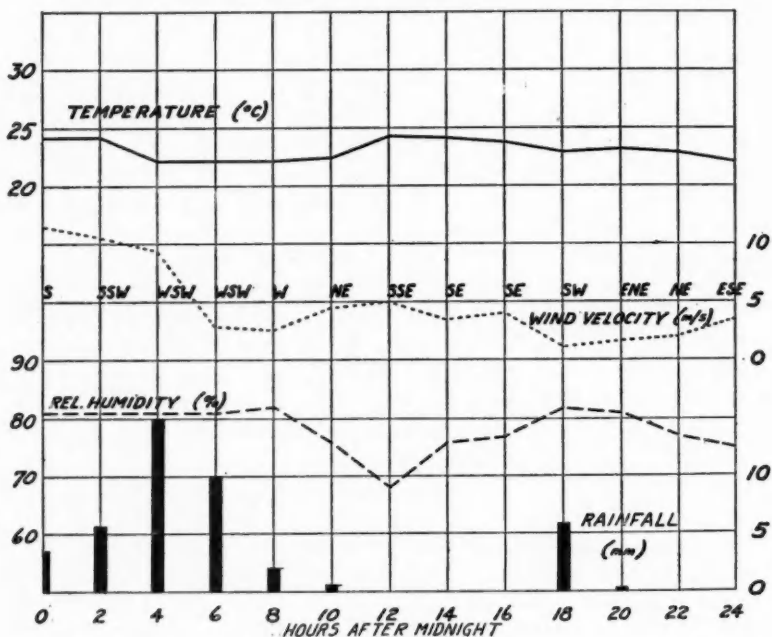


FIG. 21.—Bi-hourly data during a kona storm, Pearl Harbor. Note the lower temperature during the rainy periods. (December 12, 1937.)

¹² L. H. Daingerfield, "Kona Storms," *Monthly Weather Review*, Vol. 49, 1921, pp. 327-329.

G. D. Gilman, "A Kona Storm," *Papers of the Hawaiian Historical Society*, Number 12, Honolulu, 1905, pp. 34-37.

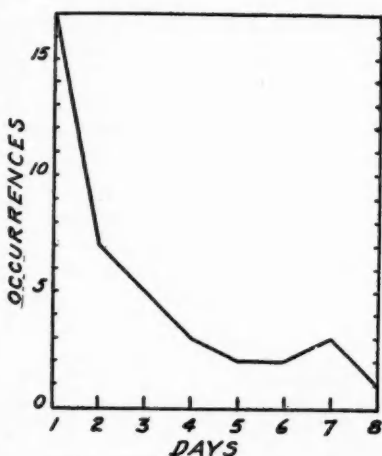


FIG. 22.—Length of cyclonic spells, Honolulu, in 1927-28.

conditions being unprecedented in the Honolulu record. In the fall of 1935, kona weather prevailed from September 20 to November 17, light winds from northerly directions having maximum duration. During this long kona spell, two men, approaching the islands from the north in a sailing vessel, narrowly escaped starvation.¹⁴

Since kona rain is primarily frontal, it is less influenced by orography than is trade wind rain (Figures 17 and 23). While the front is high, rain

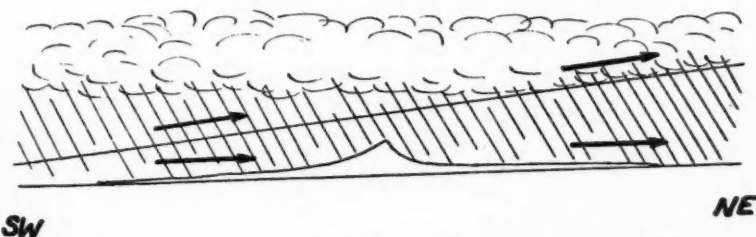


FIG. 23.—Schematic cross-section of the island of Oahu during a frontal passage (warm front or occlusion). In this diagram, both air masses are shown as stable, giving only stratus clouds above the front. Commonly both will be sufficiently unstable for cumulus cloud and showers to occur, along with the general rain.

¹³ H. R. Byers, "The Air Masses of the North Pacific," *cit.*, p. 323.

¹⁴ E. de Bisschop and C. Withington, "The Last Cruise of the 'Fou-Po,'" *Atlantic Monthly*, Vol. 158, 1936, pp. 555-564.

may be general over mountains, lowlands, and oceans. Orographic effects are not lacking, however. On the low mountains of Oahu (ca. 1000 meters), the heaviest cyclonic rain is carried over to the northeast, or *pro tem*. leeward, slope (Figure 17), much as trade wind rain is carried over in the reverse direction.¹⁵ Such carry-over is probably partly mechanical, partly the completion of convection initiated by orographic lifting.

Since kona winds are a reversal of one of the steadiest air movements of the globe and since kona storms move across one of the most stable features of the general circulation—the subtropical anticyclone—their frequent occurrence is the more remarkable. An explanation is suggested: The centers of most North Pacific cyclones pass far north of the Hawaiian Islands.¹⁶ Passages of the troughs of such cyclones produce saddles in the subtropical high. The high pressure belt, moreover, tends to break up into anticyclonic cells because of the great width of the Pacific Ocean.¹⁷ The circulation about such saddles should tend to produce a front, in the case of the North Pacific, if the isotherms trend approximately southwest-northeast.¹⁸ Since an extratropical cyclone normally is preceded by warm and followed by cold air, a southwest trending front across the anticyclonic belt should be a common accompaniment. Secondary cyclones may develop along such fronts¹⁹ and move in northerly directions.

Whether any kona storms can properly be called tropical cyclones is debatable. Hurd and Visser believe that tropical cyclones occasionally

¹⁵ The analysis summarized in Figure 17 proves erroneous an earlier assumption of the writer's: "That the maximum rainfall (on Oahu) of more than 240 inches occurs on the southwest, or leeward, side of the Koolau Range is due to the overlapping of the summits by trade-wind rains and to downpours accompanying southerly storms." (Italics added.) S. B. Jones and R. Bellaire, "The Classification of Hawaiian Climates," *Geographical Review*, Vol. 27, 1937, p. 112. The senior author is responsible for the statement. Cf. G. Schott, "Klimakunde der Südsee-Inseln," *Handbuch der Klimatologie*, Band 4, Teil T, Berlin, 1938, p. 21.

¹⁶ R. W. Richardson, "Winter Air-mass Convergence Over the North Pacific," *Monthly Weather Review*, Vol. 64, 1936, pp. 199-202.

P. J. Harney, "Note on H. C. Huang's Investigations of Frontogenesis in the North Pacific," *ibid.*, Vol. 65, 1937, pp. 335-337.

¹⁷ M. Rodewald, "Eine sekundäre subtropische Zyklonenbildungsstätt im mittleren Nordpazifischen Ozean," *Annalen der Hydrographie und Maritimen Meteorologie*, Vol. 64, 1936, pp. 433-436.

This tendency may account for some of the variation in the velocity and depth of the trade winds, both summer and winter, without fronts or kona weather. Cf. T. A. Blair, "Note on Trade Winds in Hawaii," *Monthly Weather Review*, Vol. 51, 1923, pp. 525-526.

¹⁸ Petterssen's theory. H. R. Byers, *Synoptical and Aeronautical Meteorology*, New York and London, 1937, pp. 147 ff.

¹⁹ H. R. Byers, "The Air Masses of the North Pacific," *cit.*, p. 322.

approach the islands.²⁰ Certainly, many kona storms originate within the tropics, so it is in part a question of definition. If we restrict "tropical cyclone" to storms of hurricane type, we may say that the season of great frequency is autumn, that, whatever the initial impulse, their energy comes chiefly from condensation rather than from contrasting air masses, and that winds of great violence circulate about a central eye. Kona storms occur throughout the winter, often show distinct fronts, and have not brought the Hawaiian Islands winds much in excess of twenty-two meters per second (fifty miles per hour). In this problem, as in many others, we are brought to a halt by the scanty synoptic data from the central Pacific.

THE EQUATORIAL FRONT

In this meteorologically little-known central Pacific there is no true "Belt of Calms." The northeast and southeast trades meet, usually, at a moderate angle.²¹ Since the air masses on both sides of this intertropical or equatorial front come from similar sources and have had similar histories, temperature and humidity differences are slight. Usually the front, in the central Pacific, is characterized by cloud cover and rain, but squalls and storms may arise. Kingsford-Smith encountered severe weather at the equatorial front in 8° south latitude on his northward Pacific flight.²² On July 3, 1937, a naval seaplane, sent from Pearl Harbor in search of Earhart and Noonan, was turned back by a large and violent storm six hundred kilometers north of Howland Island, with snow at elevations of 900 to 3700 meters and clouds estimated to 5500 meters—no mere trade wind shower.²³ The regularity of the summer trade winds in Hawaii shows that the actual front seldom lies as far north as the islands. The slight secondary maximum of rainfall in summer, observed at many Hawaiian stations, presum-

²⁰ S. S. Visser, "Tropical Cyclones of the Pacific," *Bernice P. Bishop Museum Bulletin* 20, Honolulu, 1925.

Idem., "Frequencies of Tropical Cyclones, Especially Those of Minor Importance," *Monthly Weather Review*, Vol. 58, 1930, pp. 62-64 (includes bibliography).

W. E. Hurd, "Tropical Cyclones of the Eastern North Pacific," *ibid.*, Vol. 57, 1929, p. 47.

²¹ C. E. P. Brooks and H. W. Braby, "The Clash of the Trades in the Pacific," *Quarterly Journal of the Royal Meteorological Society*, Vol. 47, 1921, pp. 1-11.

W. G. Ramsay, "Meteorological Conditions on Baker and Howland Islands," *Monthly Weather Review*, Vol. 53, 1925, p. 23.

E. A. Beals, "The Northeast Trade Winds of the Pacific," *ibid.*, Vol. 55, 1927, p. 216.

²² P. G. Taylor, *Pacific Flight*, Sydney, 1935.

²³ *Honolulu Star-Bulletin*, July 5, 1937, p. 1.

ably is related to the most northerly position of this wind divide, near which trade wind inversions probably tend to disappear.²⁴

OTHER WEATHER FEATURES

Thunderstorms are so much a feature of the text-book description of low latitude climates that visitors are surprised by their rarity in the Hawaiian Islands.²⁵ Honolulu averages five a year, almost all of which are mild. The stability and dryness of trade wind air above one or two thousand meters, with the frequent presence of isothermal layers and inversions, are unfavorable to penetrative convection. Hail, though rare, is not unknown. A few waterspouts have been observed.

From the foregoing discussions, it is apparent that the Hawaiian Islands receive little weather unfit for aviation or for navigation in large ships. Yachting, commercial fishing, and landing at open roadsteads are, at times, dangerous. Fog at sea level is unknown, though planes have been grounded by heavy rains which have also compelled ship navigators to sound fog signals. Violent vertical currents in unstable cold-masses or along cold fronts may make flying unpleasant or even dangerous. Planes were lost during the 1938 naval manoeuvres, possibly by crashing into the sea while flying under low-lying frontal clouds. However, Trans-Pacific airline operators consider Hawaii one of their least troublesome areas and inter-island air service has an excellent record of safety and schedule fulfillment.²⁶ Variations in depth of the trades, with winds from southerly and westerly directions aloft, frequently make possible the selection of favorable levels for long-distance flights. Much of the trans-Pacific flying is done at 3000

²⁴ Cf. H. von Ficker, "Die Passatinversion," *Veröffentlichen des Meteorologischen Instituts der Universität Berlin*, Band I, 1936, Heft 4.

A very thorough analysis of rainfall regimes in Hawaii has been made by H. Tüllmann, "Die Niederschlagsverhältnisse der Südsee-Inseln," *Aus dem Archiv der Deutschen Seewarte*, Band 56, Nr. 5, Hamburg, 1936. Tüllmann describes the summer secondary maximum as "zenithal rain."

It does not detract from the general excellence of this work to point out that Tüllmann's explanation of heavy rainfall on the lee slope of the Koolau Mountains (p. 30) seems improbable and that his explanation for the frequency of dry Februaries (pp. 31-32) is based on pilot charts compiled for years in which dry Februaries were not numerous. (W. Werenskiöld, "Mean Monthly Air Transport over the North Pacific Ocean," *Geofysiske Publikationer*, Vol. 2, 1933, p. 4.) The number of dry Februaries in Hawaiian records in the present century is truly remarkable. The February minimum tends to disappear, or even be replaced by a maximum, in records extending well back into the nineteenth century.

²⁵ Cf. A. Thomson, "Thunder and Lightning in the South Pacific Ocean," *Monthly Weather Review*, Vol. 58, 1930, pp. 327-329.

²⁶ In 1937 there were only four cancellations for weather in more than 1000 scheduled inter-island flights, although no instrument flying was attempted. Heavy rain at landing fields was the main reason for cancellation. (Personal communication from F. B. Connell, Inter-Island Airways.)

meters or so, for favorable winds, economy of operation in rarified air, and to be above the usual cumulus clouds.

HEALTH, ENERGY, AND COMFORT IN HAWAII

Perhaps the most variable feature of the Hawaiian climate is what people think about it. Significant adverse effects upon health have not been proved. Burrows shows that the death rate is lower in the summer months, when temperatures are most "tropical" and least variable (Figure 13).²⁷ He found no significant increase in death rate due to kona weather. The worst kona weather is but a feeble imitation of a North American hot wave. Peterson believes that changes, especially in humidity, affect the condition of patients.²⁸ Respiratory diseases are commonest in the cooler months, just as in middle latitudes (Figure 24). Some supposedly tropical dis-

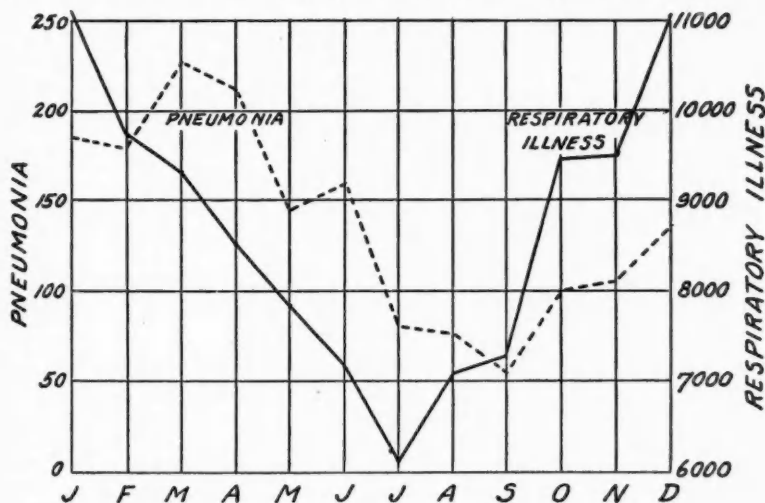


FIG. 24.—Pneumonia (lobar and bronchial) and acute respiratory illnesses on Hawaiian sugar plantations, 1934-1936, reduced to rates per 100,000 population. Data supplied by Nils P. Larsen, M.D., Queen's Hospital, Honolulu.

eases are proving to be little different from their middle latitude relatives. Anemia, common among plantation children, is decreasing as more attention is paid to diet.

²⁷ E. G. Burrows, "Climate and Health in Hawaii" (abstract), *Proceedings Hawaiian Academy of Science*, Bernice P. Bishop Museum Special Publication 21, Honolulu, 1933, pp. 7-8.

²⁸ W. F. Peterson, *The Patient and the Weather*, Ann Arbor, Vol. 1, Part 2, 1936, Chapter 12, and Vol. 4, Part 3, 1938, p. 56.

There is likewise no clear proof that prolonged residence in Hawaii produces slow deterioration in white people or that successive generations are enfeebled. The race supposedly least adapted to the tropics, the Nordic, shows in Hawaii by far the best standard of health. Economic status permitting better food, medical care, and living conditions is obviously the reason. Some Nordic families have lived in the islands four or five generations and continue to produce vigorous children. There is no strong tendency for island affairs to be run by recent arrivals from cooler regions. Whether these observations can be extrapolated to climates more equatorial than Hawaii's is another question. How much depends upon the very slight winter, persistent winds and generally moderate humidity, and occasional trips to cooler climates cannot readily be assessed.

Energy in tropical climates is not necessarily subject to the same laws as health. The work of Huntington has indicated that changes of temperature are energizing. That they may also precipitate illness is not contradictory. It is generally believed that life in Honolulu is more leisurely than in mainland cities of similar size. But one must not jump to the conclusion that the slow movements of pedestrians, for example, are indicative of mental or physical lethargy, for some of the same individuals may show extraordinary agility on athletic fields or in fishing expeditions. In default of quantitative data, perhaps the most that can be said is that the release of energy, in Hawaii, requires somewhat greater motivation than is needed in cooler and more changeable climes.

Comfort is a highly subjective matter. Whether one works with mind or body, in the shade or in the sun, in clothes determined by comfort or by puritanical tradition, are contributory factors. On most trade wind days, the shade temperatures are sufficiently close to a comfortable level for individual differences to be decisive (Figure 25). Most new arrivals and many old residents call the summers warm or hot, the winters pleasant except for kona spells. Some, however, consider the summers pleasant, the winters damp and cool. Slight as the annual range seems—and it is less than the normal diurnal range—there can be said to be, at sea level, warm and cool seasons. By middle latitude standards, of course, the cool season is short. A winter tourist in Honolulu finds the days pleasant and not enervating. Some nights seem cold, in draughty houses. Dew is common in winter. Some tree species lose their leaves for a short time. Spring advances slowly, as befits an insular climate (Figure 26). May and June bring vivid floral displays, which continue, less spectacularly, through summer. The warmest days come, usually, about the first of September, though kona spells may make the autumn more unpleasant. November usually is the month of most rapid fall in temperature. The low

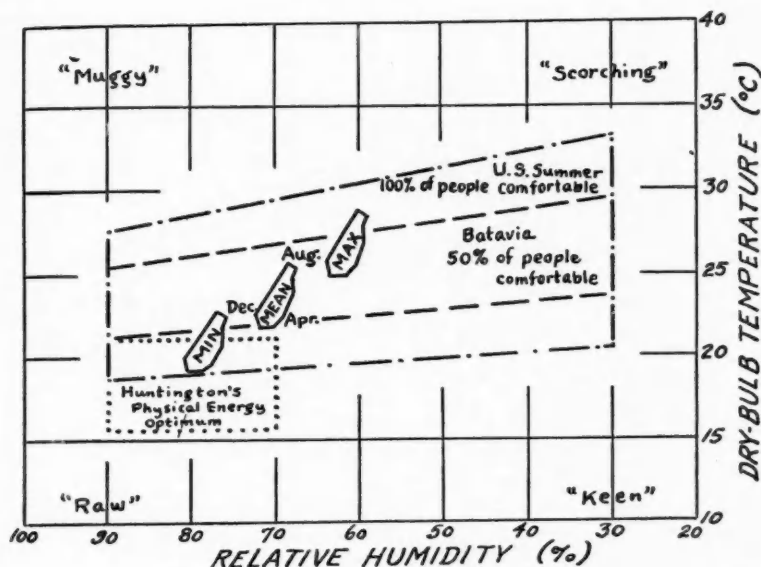


FIG. 25.—Climograms for Honolulu, showing monthly mean, mean maximum, and mean minimum temperatures, compared with comfort limits.

point of winter, in the averages, comes about the first of February, but the cyclonic element makes averages least reliable in this season.

CONCLUSIONS

In this brief and essentially descriptive account of Hawaiian weather, more questions have been raised than answered. Beyond the immediate objective of describing weather changes in a trade wind climate, this paper has the ulterior purpose of calling attention to the needs of Pacific climatology. Neither climatic averages nor synoptic reports are available over vast stretches. In an area ten times that of the United States, temperature and humidity measurements of the upper air are made at only one point. Lack of money and a tendency to regard the central Pacific as meteorological No Man's Land are the chief reasons for this dearth of information. It is the more to be regretted in view of the apparent linkage of climatic and weather changes throughout the Pacific.²⁹ Fortunately, the beginning of Trans-Pacific aviation and the occupation of small islands as air bases permit an optimistic outlook. It is important, however, that the information

²⁹ J. B. Leighly, "Marquesan Meteorology," *University of California Publications in Geography*, Vol. 6, 1933, pp. 147-172, and references therein.

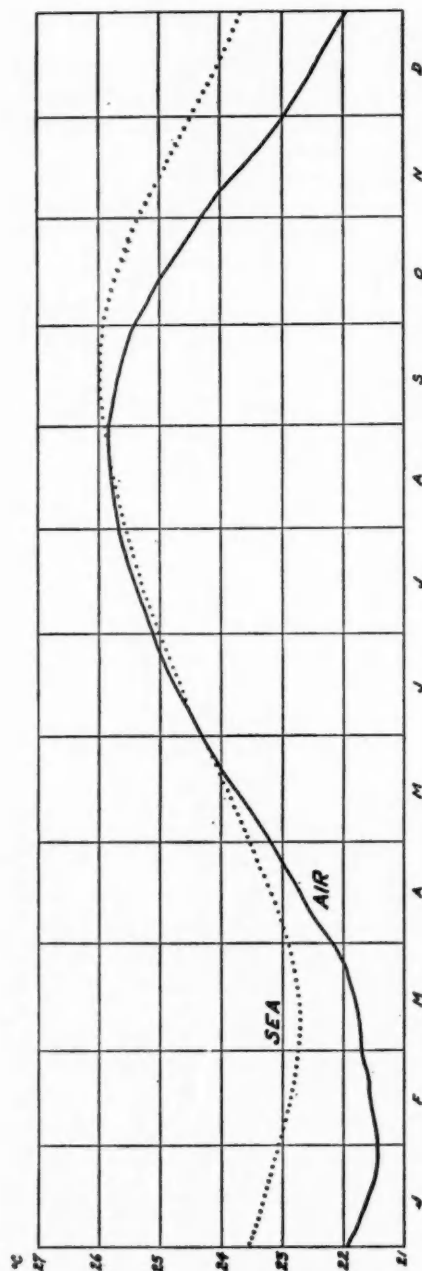


FIG. 26.—Annual march of land and sea temperatures. Land temperatures are for Honolulu (U.S.W.B.) station), from *Monthly Weather Review, Supplement 25*. Sea temperatures are from charts of the Hydrographic Office, for a location immediately northeast of Oahu.

so obtained be subjected to regular and sustained research analysis and not dropped into obscurity as soon as forecasts have been made. It is to be hoped that balloons equipped with radiometeorographs will be sent up, at least occasionally, from many places in the Pacific and that "robot" stations will be perfected and installed on islands not permanently occupied.³⁰ Even in this day of aircraft, it would be of great value to make continuous records on one of the high mountains of Hawaii.³¹ Liaison between work in Asia, North America, and the Antipodes can be strengthened. Because of its great size, the Pacific is probably the best part of the world in which to study the general circulation of the atmosphere. It approximates that "uniform rotating globe" with which so many assumed circulations begin.

*University of Hawaii,
December, 1938.*

³⁰ C. B. Pear, Jr., "An Automatic Temperature Reporting Station," *Bulletin of the American Meteorological Society*, Vol. 17, 1936, p. 265.

M. Rigby, "Robot Weather Stations," *ibid.*, Vol. 17, 1936, p. 324.

W. R. Gregg, "Radio-meteorographs for Unmanned Balloons," *ibid.*, Vol. 18, 1937, pp. 302-303.

³¹ Cf. a suggestion by Hann in 1905 (*Monthly Weather Review*, Vol. 34, 1906, pp. 222-223) and a resolution of the Pacific science congress in 1920 (*ibid.*, Vol. 48, 1920, p. 467).

Titles and Abstracts of Papers Cambridge, Massachusetts, 1938*

V. C. FINCH.

Geographical Science and Social Philosophy.

Presidential Address. Published in full in this issue.

EDWARD A. ACKERMAN. (Introduced by Derwent Whittlesey.)

The Sequent Occupance of a Boston Suburban Community.

A ring of small truck-gardening areas surrounds the Boston metropolitan district. The proximity of a large city market, plots of level land and fertile soil determine the existence of these suburban farming communities. Many of them have been occupied since the early seventeenth century, and where their history is known they provide interesting studies in sequent occupance. Concord, twelve miles from the center of Boston, is typical of these gardening areas. The small Concord lowland has been cultivated without interruption since the English settled there in 1635, and it was occupied before that by Indians for a period of unknown length.

On cultural and environmental bases it is possible to establish four main periods of occupance in the area: the aboriginal Indian; the colonial period of subsistence farming (1635-1775); the dairying period (1775-1880); and the modern era of intensive truck gardening and residential property expansion. Behind each community, Indian, colonial, or modern, has lain a definite set of environmental factors—some, like climate or soil, unchanging; and others, such as relation to centers of population, or technical knowledge, never alike.

With the exception of a brief period of manufacturing during the Revolutionary War Concord community until recently was dependent primarily on agriculture. But increasing competition with out-of-state truck farming has reduced the importance of local gardening, and improved transportation is encouraging the development of Concord as a suburban commuting town. Concord seems destined to a new period of occupance as a country estate and suburban residential center. Its future, however, is dependent upon Boston, which has determined all of the other stages in Concord's development.

*The word "(Exhibit)," at the end of an abstract denotes a showing of illustrative material in the exhibition rooms. See page 102.

ALFORD ARCHER. (Introduced by Eugene Van Cleef.)

The Effects of Shifting Political Boundaries upon a Geographical Hinterland.

The term hinterland is often used in referring to a region to the rear of a littoral which is dependent geographically and economically upon it. The geographic hinterland of a port is that area in which the movement of commodities occurs along materially advantageous routes through the port. The economic hinterland is determined by the traffic facilities associated with the port and the freight rate structure.

Under normal conditions, when trade between a port and its hinterland is not affected by human machinations, the geographic and economic hinterlands are nearly coextensive. But when political boundaries are juggled to suit man's whim or when artificial measures are enforced to direct traffic to or away from an area, then geographic and economic hinterlands may be in violent maladjustment.

The present trade situation in Stettin, Germany, illustrates a geographic dislocation. Stettin enjoyed increasing prestige as a port until the peak of her activities was reached at the time of the World War; but in the year 1919 a decline set in which has continued to the present. Because of (1) the creation of the Polish Corridor and the founding of Gdynia as a competing port, and (2) the establishment of freight rates in the new country favorable to competitive ports, much of Stettin's geographic hinterland has been incorporated in the economic hinterland of Gdynia to the east and Hamburg to the west.

WALLACE W. ATWOOD.

The Recession of Victoria Falls.

The world famous falls on the Zambesi have had a strange and remarkable history in recession. The gorge is serpentine with many curious offshoots, and located on the floor of a broad and much older flat-bottomed valley.

Today the water tumbles over a ledge, fully a mile in length, and into a very narrow chasm 350 ft. deep. The falling waters face a precipitous cliff a few rods away. The exit of the waters is all through a very narrow passageway about midway between the present ends of the falls.

An explanation of this curious and probably very unique phenomenon is problematical, but, with the help of a diagram and photographic illustrations, a working hypothesis was presented.

JAMES W. BAGLEY. (Introduced by C. H. Birdseye.)

Theory and Use of a New Stereo-map-plotting Instrument.

The purpose of the stereo-map-plotting instrument is to expedite the

preparation of topographic maps from aerial photographs, especially in application to transformed obliques taken with multi-lens cameras.

It is based on the radial line principle of locating objects by direction lines drawn from the center of vertical point of a photograph and of utilizing simultaneously companion directions from a pair of photographs of the same terrain to give locations of objects and to trace details on a map sheet in their proper positions.

The instrument consists of four essential parts. These are (1) an adjustable stereoscope, (2) a mount for the stereoscope which permits it to be brought readily into position over the photographs or quickly moved out of the way, (3) the plotting mechanism proper, consisting of two slotted arms, pivots and a moving pencil, and (4) a thin board or sheet of metal for placing the photographs and map sheet together to bring them readily into convenient position under the stereoscope. The entire assembly is used on a horizontal table large enough to permit operation without interference.

The instrument is intended especially to supplement the five-lens and nine-lens aerial cameras for mapping, the photographs being taken to give the most satisfactory arrangement for this type of plotting. It permits maps to be plotted at any desired scale within wide limits ranging approximately from one-fifth to twice the scale of the photographs.

Lantern slides were employed to demonstrate the mathematics and method of using the instrument.

(Exhibit.)

CHARLES H. BEHRE, JR.

The Geography of Southwestern Sardinia.

Southwestern Sardinia, the smaller part of the island, is separated from the more rugged northeastern section by (1) the Campidano. This part also includes (2) the Cixerri trough, (3) the Arbus and adjacent mountains north of the Cixerri, and (4) the Capoterra-Sulcis ranges of the southwestern region. These features are shown in detail on the maps of the Istituto Geografico Militare.

The Campidano is a broad, northeast-trending trough, 20-25 by 90 kilometers in area. To the northeast and southwest highlands rise abruptly from this depression, flanked by broad piedmont alluvial fans. The trough itself is noticeably terraced, and bordered by small volcanic plugs, the sites of ancient castles. At the south the Campidano is still flooded by the sea; here are the large salt "farms," important sources of a valuable export from the excellent small harbor of Cagliari. To the northwest the Campidano terminates in another once swampy tract, now the model farm Mussolinia.

The Campidano is now largely drained and the salt washed from its soil. This combats malaria and enlarges the arable land, which is cultivated in contour strips, progressively from lowest to highest in wheat, artichokes, beans, and orchards.

The Cixerri trough has similar characteristics, branching westward from the Campidano. Its alluvial fans, largely dissected, cover its slopes, and are continuous higher up with marked erosion terraces. The floor of the main valley rises westward, the trough disappearing near Iglesias. Less depressed than the Campidano, this trough harbors orchards along its floor.

The two mountain regions bordering the Cixerri are rugged, rising to a maximum height of 1240 meters though only some 17 kilometers from the sea. Their seaward slopes exhibit remarkable marine terraces (peneplains?), some at 230 meters altitude, others only at 30 meters. The Arbus mountain area is largely underlain by resistant granite and is an enclosed altiplano at 325-400 meters. Near this are the great mines of Sardinia, producing especially zinc, with some lead and silver. But cork-growing and stripping and the herding of goats and especially of sheep are thriving industries here. The southern mountain massive is similar but bears far fewer mineral deposits and is more sparsely settled. Along its western coast manganese oxides and lignite offer possibilities, the latter already somewhat exploited.

Culturally the small towns are either mining centers, dependent on neighboring food sources, or rural hamlets, largely self-sufficient. Human development in southwestern Sardinia does not show typically Sardinian culture to so marked a degree as in the rugged northeast. Southwestern Sardinia is less distinctive for geographic and historical reasons, having been accessible to alien penetration by Greeks, Carthaginians, Romans, Moors, Spaniards, and continental Italians.

NELS A. BENGTSON.

The Farm Price of Wheat in Relation to the Great Transportation Routes of the United States.

This study deals with regional differences in the farm values of wheat produced in the United States. The period 1915-35 was chosen because the abnormal conditions of the war years and those of the depression years could be offset by the intervening decade. The average conditions computed and illustrated may be considered typical for the recent period.

On the basis of the 20-year average, the six states of highest prices had an average farm value of \$1.59 per bushel whereas the seven states of lowest farm prices during this same period had a corresponding figure of only \$1.02. Immediately preceding the beginning of this double decade

the main wheat surplus region extended unbroken from Ohio to Oregon and Washington. Since then significant changes have occurred. For the five-year period 1928-1932 the average production caused Ohio, Illinois, Iowa and Nevada to become wheat-deficiency states, while Texas and New Mexico were added to the group of surplus producers. The following five-year period, 1933-37, restored Ohio and Illinois to the surplus producing states and reduced New Mexico and Texas to the deficiency list. The permanent change seems to have reduced Iowa and Nevada from surplus to deficiency status since 1910.

There are three centers of relatively high farm prices for wheat in the United States, Maine, South Carolina, and Arizona. Each is separated from the others by great routes of wheat shipment, (1) the eastern route across the Middle Appalachians via the Mohawk-Hudson gateway or across gaps in the barrier cut by the Delaware, Susquehanna, or Potomac rivers, and (2) the Mississippi River and Valley with its railroad facilities.

The centers of relatively low prices are in Colorado and Idaho. In each case the location is on a "divide" insofar as producing areas in relation to shipping facilities are concerned.

East-west price profiles across northern, middle, and southern United States show broad similarities in their troughs and marked differences in their ascending seaboard curves. The north-south profile from North Dakota to Texas illustrates the low price basin from South Dakota to Kansas with moderate upturns for North Dakota and Texas.

Special studies for the 1928-32 and 1933-37 periods bring out the same general profile curves as prevailed for the longer period, 1915-35. The regional distribution of "highs" and "lows" of farm wheat prices remains constant through varying price levels. The price profiles for 1928-32 illustrate the extent of the price depression from the 1915-35 average. The profile of average farm prices for 1933-37 differs more in form from the 1915-35 curve than does the 1928-32 profile; probably a reflection of unprecedented drought over much of the larger wheat region, and attempts at price stabilization carried out by government policies.

CLAUDE H. BIRDSEYE.

The Fifteenth International Geographical Congress at Amsterdam, July, 1938.

The Fifteenth International Geographical Congress was held in Amsterdam, July 18-28, 1938. More than 1,200 members were enrolled, including over 70 from the United States. Nearly 1,000 of those enrolled, including 45 from the United States, were registered and present. The attendance was the largest meeting of the International Geographical Union that has been held.

A preliminary report of the Congress is published in the October, 1938, number of the *Geographical Review*. This report was written by two of the official delegates, O. M. Miller and C. B. Hitchcock, and covers the organization of the Congress, the business of the Sections, the exhibitions of maps and the excursions both before and after the Congress. Other reports are published in the *Geographical Journal* for October and for November, 1938; in *Petermanns Geographische Mitteilungen* for September, 1938; and in *La Géographie* for September-October, 1938.

The organization of the Congress was admirably arranged by the Netherlands National Committee for Geography, which delegated the work to a small organizing committee with Prof. J. P. Kleiweg de Zwaan, as president, Capt. E. J. Voote as secretary, and four other members. Largely due to the very efficient preparatory work of this committee, the program of the Congress was carried through without confusion or delay.

The official opening took place on July 18, at the Concertgebouw. Sir Charles Close, President of the Congress, gave the opening address and introduced the Dutch Minister of Instruction, who welcomed the members of the Congress in the name of the Queen. Sir Charles then introduced the chiefs of the German, United States, French, Italian and Polish delegates who responded to the address of welcome.

A number of resolutions passed by the various sections were submitted to the Executive Committee. Most of these were referred either to the National Committees for recommendations, or to the new Executive Committee with power to act.

The new president of the International Geographical Union is Prof. Em. de Martonne of Paris, and the new Secretary-General is Prof. P. L. Michotte of Louvain, Belgium. Sir Charles Close of Eastbourne, England, becomes the first vice-president and represents Great Britain; Prof. W. E. Boerman of Rotterdam continues as vice-president representing Holland; Prof. L. Mecking of Hamburg, Germany, continues as vice-president representing Germany; Prof. A. R. Toniolo of Bologna, Italy, replaces Prof. Dainelli and is the vice-president representing Italy; Prof. Stanislaw Pawlowski of Poznan, Poland, replaces Prof. Romer and is the vice-president representing Poland; and the speaker replaces Dr. Bowman and is the vice-president representing the United States.

The place of meeting of the next Congress in 1942 was not decided, two informal invitations being unofficial, and the acceptance of the invitation from Belgium being complicated by the practice of the Union not to hold successive Congresses in contiguous countries. The matter was therefore left to the new executive committee.

S. WHITTEMORE BOGGS.

The Historical Geography of the United States-Canada Boundary.

In the modern world, transcontinental boundaries are found only in North and Central America. Three of them are those of the United States and its territory of Alaska—two with Canada and one with Mexico. One of these, the United States-Canada boundary, nearly 4,000 miles long, has been the subject of negotiations in more than twenty treaties and conventions, and of two arbitration proceedings.

The definitive edition of the treaties of the United States which is now being published includes extended scholarly notes; this, together with certain other publications, contains a wealth of information relating to the United States-Canada boundary. But at the present time it is difficult to discover the most pertinent material bearing on the delimitation and demarcation of any portion of the boundary. Within the last year the original treaties and other documents of the United States have been transferred to the National Archives. The six reports of the international boundary commissions, which now cover the entire boundary, total nearly 2,400 printed pages, the last report having been published in 1937.

It now seems opportune to review the history of the establishment of the boundary between the United States and Canada, to consider the principal geographical problems that were involved in controversies that persisted for more than a century, to consider the geographic factors of the completed boundary, and at the same time to provide convenient apparatus to facilitate the use of the most authoritative and pertinent materials relating to the boundary as a whole and to any particular portion in which a student may be interested. Within the limits of allotted time, an outline of such a study is attempted.

(Exhibit.)

WILLIAM B. BRIERLY. (Introduced by Wallace W. Atwood.)

Geographic Factors in the Distribution of Typhus Fever in the United States.

Endemic murine typhus fever, characterized by a late summer and fall incidence, high fever, mildness and a spotted exantem, is found endemically in certain sections of some of our Southern States. Typhus fever has an annual incidence of about 1700 cases and over 100 deaths. The natural reservoir for the *Rickettsia* organism causing typhus fever, is found in the common rat, *Rattus norvegicus*, and is transmitted from the rat to man by the rat flea, *Xenopsylla cheopis*. The distribution of typhus fever seems to coincide rather closely with the zone of peanuts, pecans and small crops of the South, from which the rat obtains a plentiful supply of food.

Natural conditions within this zone favor greater incidence and distribution of rats within the zone, which in turn allows for a greater increase in typhus fever. The mobility of the rat is not conducive to spread of the disease far beyond the peanut zone, but a few years ago health authorities noticed that typhus fever was extending northward.

Investigation has revealed a new reservoir in the field mouse which will account in part for this spread. Field mice are distributed over the entire United States, roughly east of the Mississippi River. Typhus fever may in the future present a real menace due to its increased mobility with the field mouse, in the heavily populated districts of the Northern States. Knowing geographical conditions in America and comparing them with similar conditions in Russia, where typhus has spread much further north, we may reasonably assume that typhus may in time invade our heavily congested northern communities. Experimentation has shown that it is possible for endemic typhus to become epidemic in nature if it be carried by the body louse. This has not taken place in the Southeastern States due to the fact that overcrowding is not present and body lice uncommon. In the northern congested areas lousiness is common among the lower strata of society, therefore we have in the United States a beginning of a menace that may in the future take a severe toll in human life.

(Exhibit.)

CHARLES F. BROOKS.

West Indian Hurricanes that Blast New England.

Storms of tropical origin affect New England every year. Three times in five years, on an average, their centers pass over some part of New England, usually attended by excessive rains, and often gales. Five times in fifty years some of the most intense of these storms, originally West Indian hurricanes, are still strong enough when they reach here to cause great damage over a belt at least 20 miles wide. Once in a century or two, a full-fledged hurricane dashes out of the tropics and strikes suddenly in full vigor on a wide front. Its energy is maintained by the latent heat of vaporization in the broad stream of moist tropical air that carries it, and the whirl has not been weakened by friction over land. It batters the coast of Long Island and New England with fast-moving surf on high water and an almost irresistible wind laden with spume; it gouges lanes through the sodden forests and destroys the weaker buildings and damages the stronger in the paths of its blasts; it puts the climax on rising floods from tropical rains that have preceded it.

The descriptions of the hurricanes of August 15, 1635, and of September 23, 1815, when allowance is made for the difference in population and in

the density of vulnerable human structures, could be applied almost verbatim to that of September 21, 1938. Their antecedents and tracks differed in detail, but they all came on suddenly and lasted but a few hours.

In the storm of 1938 the sea water in the area of reduced pressure and converging winds rose 10 to 15 feet above normal high tide from Falmouth to Stonington or Saybrook and 6 feet or more west to Sandy Hook. The storm tide caused greater loss of life and coastal damage than has ever before been experienced on the North Atlantic seaboard. The destructive effect of the wind itself was greatest among trees, while buildings were damaged nearly 200 miles inland. The wind velocity reached hurricane force from 120 miles east of the path of the center to 60 miles west. This greater eastward than westward range of destructiveness was due to the fact that on the east the whirling motion of the storm was added to the velocity of the forward progress. A central eye of light winds about 40 miles in diameter disappeared in southern New England as friction weakened the cyclone. The path was east of north till near Hartford, then northward, and finally northwestward, entering Canada. Its progress averaged more than 50 mi./hr. from Hatteras northward, and at times apparently exceeding 60 mi./hr.

MEREDITH F. BURRILL. (Introduced by Clarence F. Jones.)

Manufacturing in Oklahoma.

Oklahoma's industrial development reflects (1) the presence of natural resources that require little processing and relatively little industrial labor, (2) the special importance of the oil industry, (3) the growth of urban service industries to but generally not beyond the consuming capacity of the local market, (4) the concentration of manufacturing in or around the largest cities, (5) the restricted market for manufactures within the state, and (6) the importance of transportation as a locating factor.

Small industries predominate but big factories dominate. Hundreds of small establishments make such things as bakery products for their communities, but a few refineries and other large plants do most of Oklahoma's manufacturing. In every post-war census of manufactures, oil refining has accounted for one-third to one-half of the value of product in the state, one-fifth to one-third of the value added by manufacture, and one-sixth to one-fifth of the wage earners.

The most numerous and widely distributed of the small establishments are the newspaper and job printing shops, bakeries, ice plants and dairy manufactories.

Oklahoma has oil, natural gas and coal; zinc, lead, gypsum and glass sand; raw materials from farms and ranches; a potential labor supply, and

a good network of railways and highways with adequate outside connections.

Oklahoma industries do not have large markets within the state and are not well located to serve outside markets; water supplies are too often inadequate or of poor quality; few of the available workers are skilled; and the state has not yet achieved sufficient governmental stability to attract industrial capital.

ALBERT S. CARLSON. (Introduced by Clarence F. Jones.)

Site Factor Handicaps in Cities of the Merrimack Valley, New Hampshire.

Regional handicaps of New England industry are stressed frequently. However, site handicaps within communities often are equally important. Cities in the Merrimack Valley of New Hampshire illustrate site features and associated problems typical of many New England cities with valley locations.

Franklin and Laconia offer practically no suitable sites for new or expanding industry. In Franklin manufacturing plants are located on narrow flood plains backed by steep terrace slopes subject to frequent floods. Laconia does not have a flood problem but her manufacturing areas are limited by hills and lake shores.

Concord, with the handicap of little level land adjacent to railways that is not subject to flood, lacks a labor supply suitable for New England manufacturers because its central position in the state has led it to be chosen the capital and a center for service industries paying high wages.

Manchester and Nashua reflect the early start and growth to dominance of one manufacturing company in each city specializing in textiles. Each company purchased water rights and adjacent terrace lands for canal and building construction and assumed ownership of contiguous properties. The textile plants, forming the core of the industrial patterns, lie on the river terraces at the source of water power and supply. Plants of more recent date, housing shoe, metal, building and wood products industries, lie along railways and highways that radiate from the textile core. Recent failure of the Amoskeag Manufacturing Company in Manchester has changed the similarity of industrial patterns in the two cities. Textile features dominated the industrial patterns. The condition continues in Nashua today but not in Manchester where shoe manufacturing leads. Shoe factories located along the railways away from the Merrimack now form the core of the industrial pattern. Miscellaneous industries and vacant floor space supplant former textile operations. New or expanding industries must locate in old textile mills or on bits of land along the railways.

The study of site factor handicaps in Merrimack Valley suggests definite remedies applicable in many New England cities. Where geographic features handicap industrial development the community must favor action that will alleviate flood damage, introduce businesses that more fully utilize local and regional geographic conditions, and encourage growth of industries not so completely dependent on geographic factors. Where geographic handicaps cannot be overcome, action should be taken to lower labor costs, taxes, financing expense and transportation cost, and to improve understanding and cooperation between employers, employees and the community.

ARTHUR B. COZZENS. (Introduced by Lewis F. Thomas.)

Natural Regions of the Ozark Province.

The limits of the Ozark Province and of its natural regions have been established by a detailed analysis of the natural landscape. Geology, physiography, and forest cover are the bases for regions developed and mapped as initial steps in the delineation of the natural regions which result from the coordination of all the factors. Climate and soil are not considered separately; climate does not contribute directly to the establishment of regional or provincial boundaries, and soil is treated with geology because of the close relationship between these factors in the Ozarks and because of the paucity of suitable basic information. Wherever practicable, the procedure is quantitative.

Geology has been analyzed into those aspects of bed and mantle rock which influence other factors of the landscape. Most important of these are resistance of adjoining rock masses to weathering and erosion, structure, and order of superposition of resistant and non-resistant strata. The rocks within each region need not be of the same geologic age, but they are either uniform or uniformly varied in their significant characteristics.

Physiography is treated both qualitatively, to emphasize recognized physical divisions, and quantitatively, to present the essential characteristics of the terrain. An automobile traverse which crossed and recrossed the Ozarks furnished the basic material for the qualitative study, and a careful analysis of slope and relief data, obtained from topographic maps and field measurements, provided the fundamental material for the quantitative. As the methods employed successfully in other areas have proved inapplicable because of topographic diversity, new techniques have been devised to suit the conditions. Slope and relief are mapped separately, because they vary independently from one area to another.

The forest cover of the province was analyzed by calculating the percentage composition of numerous woods growing under definite conditions of slope, exposure, bed and mantle rock. From the data so obtained, forest

cover regions are distinguished and mapped. The classification is based principally upon dominant species, those which collectively constitute more than 50 per cent of the stand, and upon indicator species, those usually less abundant which are definitely associated with certain bed and mantle rock types. In general, the same species occur throughout the Ozarks, but the percentage compositions of woods growing on different rock types show recognizable differences.

Regional maps, based on geology, physiography, and forest cover, display marked similarities which indicate close causal relationships in the Ozarks. Stream erosion has emphasized differences in lithology and rock structure, and the resulting physiographic features have influenced the native vegetation principally through the media of slope, drainage, and exposure to sunlight. A map and description of the natural regions have been prepared to express this interrelation of all the natural landscape factors. (Exhibit.)

GEORGE B. CRESSEY.

The Land-forms of Chekiang.

One of a series of papers presented in a program on surface features. Published in full in the December, 1938, *Annals*.

(Exhibit.)

CHRISTIAN C. CROSSMAN. (Introduced by G. Donald Hudson.)

Determining the Purchase Boundaries and the Use of Reservoir Properties.

Paper No. 6 of a series of seven relating to river development in the Knoxville-Chattanooga area.

The Tennessee Valley Authority has adopted a procedure that assures the complete coordination of work pertaining to the establishment of purchase boundaries for reservoir properties and the use and management of these properties after they are purchased. The procedure consists of seven steps, each of which follows a definite time schedule for each reservoir to which the procedure is applied.

In the first step the area is delimited within which the work of the departments will fall. To afford a basis on which detailed studies can be conducted, the second step calls for general studies to be undertaken by the Land Planning Division. The data gathered under these general studies represent the sum total of requests of all cooperating departments so that only data which have specific utility are obtained.

The third step calls for technical studies by planning departments. These are confined to areas of special departmental interest which have been

discovered on the basis of the foregoing general studies. Recommendations are submitted by these departments relative to the placing of purchase boundaries. These recommendations are coordinated by the Land Planning Division in the fourth step and are submitted to the Maps and Surveys Division where they are considered in conjunction with factors of an engineering nature—the next step in the procedure.

The last two steps in the procedure require a reexamination of data obtained in the general studies of the Land Planning Division and detailed studies of other divisions represented in Steps 2 and 3 respectively. In Step 6, recommendations for the use of reservoir properties are developed and submitted by other divisions to the Land Planning Division for coordination. The seventh step consists of the development by the Department of Reservoir Property Management of management plans covering the land-use recommendations submitted in Step 6 and the continued cooperative refinement of land-use plans as new or unanticipated problems arise and have to be treated.

CHARLES M. DAVIS. (Introduced by P. E. James.)

Cattle Ranching in Middle Park, Colorado.

Cattle ranching had its beginnings on the flat, winterless plains of Texas where most of the area involved in the operations was public domain. In its spread northward it came into the "park" districts of the Colorado Rockies, a totally different setting from that in which it had its origin. The changes which were necessary to fit into this new environment affected both the economy and the land.

Middle Park, Colorado, was one of such areas and the present patterns of land utilization and land ownership are explainable in terms of the local evolution of ranching.

As substitutes for the all-season availability of the steppe grasses of the plains, the mountain country offered the various vegetation zones resulting from vertical differentiation. The bottom lands were irrigated and improved for winter pastures and summer hay fields. The lower mountain slopes could be used for extensive summer grazing. The traditional policy of the ranchers in owning little land but using much persisted for a long time. This led to overexpansion of the ranching in relation to the resources of forage available in Middle Park.

The resulting simple patterns of utilization and ownership have been complicated in the last forty years by changing national policies in regard to the public domain. The introduction of National Forests introduced federal control of the amount of stock which could be grazed on the public ranges. The Taylor Grazing Act in 1933 removed the remaining public

land from entry and brought it under the administration of the government. This crystallized the pattern of land ownership and forced the ranching economy to another readjustment.

At the present time in Middle Park ranching is gradually retrenching to a position and size in keeping with the available resources as viewed from a long-time standpoint.

RICHARD E. DODGE.

Agriculture, Market and Recreational Changes in Connecticut as a Result of the Hurricane of Sept. 21, 1938.

The inventoried damage to farms in Connecticut of over ten millions of dollars will call for an immediate adjustment of agricultural enterprises which will seek increased markets for seasonal crops. The destruction along the shore of Southern Connecticut, the relaxation center for people of Connecticut and Southern Massachusetts, has removed the market on which the vegetable growers have depended in the past.

Recreational centers will have to be found elsewhere, but many lakes have been drained because dams have been washed out and many others have lost much of their natural beauty.

These changes and others cause the agricultural leaders of the state much concern, because increased production will not be warranted in vegetables and potatoes unless markets can be assured.

STANLEY D. DODGE.

Illustrations of the Use of Population Curves in the Geographical Analysis of Western Maine.

The distribution of population can be understood only as an outgrowth of preceding distributions. At any one time the distribution of population is in process of readjustment rather more to the economic and social aspects of the utilization of land and resources than to their specific qualities. The population curve is useful in the analysis of the separate economic phases through which a population has passed. From the curves for western Maine, the advances of the frontiers of the various economic phases is derived, and from those data isochronic maps of the advance have been constructed. But, the mere fact of economic change is not enough! The quantity of change needs to be known. In the investigation of this item second derivatives of the population curves are employed, and from them isarithmic maps showing areas of related intensity of change have been constructed.

LOYAL DURAND, JR.

The Cheese Region of Southeastern Wisconsin.

The Dodge Cheese Region of Southeastern Wisconsin is one of the outstanding intensive dairy sections of the United States. Large red dairy barns, numerous silos (averaging more than one per farm), milk houses, cattle yards, night pastures, woodland pastures, marsh pastures, and permanent and rotation pastures are all important landscape elements of the region. More than 100,000 cattle produce the milk which serves as the raw material of manufacture for 214 cheese factories, 8 creameries, 5 condenseries, and in addition moves in small amounts to the Milwaukee and Chicago fluid milk and cream markets. Within the region there is at present produced more than 60% of the brick cheese made in Wisconsin, nearly all the Italian and French varieties of cheese, and about 7% of the limburger cheese and 4% of the American cheese. Dodge County as a political unit is the most important cheese-producing county of Wisconsin, contributing nearly 9% of the total production, and the state manufactures more than half the cheese of the United States.

The natural setting of the Dodge Cheese Region is the drumlin district of southeastern Wisconsin. A generally thick drift cover, the top etched by hundreds of individual drumlins, mantles the bedrock. Toward the eastern and western portions two escarpments project through the drift to rise as low wooded and pastured ridges.

The drumlins range from clusters of low, low elliptical hills fifty feet high and a mile or more in length, to short stubby to rounded oval hills one hundred feet in elevation and barely half a mile long. They are commonly oriented in a north-south direction within the region, their alignment thus being in harmony with the arbitrary man-made rectangular land system. However certain parts of the drumlin area have hills of a marked northeast-southwest trend. Where such is the case non-harmonic conditions commonly prevail, and field and road patterns depart from the rectangular cultural pattern by angles ranging as high as 45°.

The landscape character of the Dodge Cheese Region with its average 120-acre farm is given it by cultural forms, both rural and urban, associated with dairying in general but cheese manufacture in particular. The areal characteristics include not only permanent forms in given place locations, but elements of daily recurrence, such as circulation on the roads, associated with the dominant industry.

An analysis of cheese manufacture in the Dodge area shows more than fifty years of intensive manufacture, and indicates recent growth of the industry, particularly in output. New manufacturing and processing plants in the villages and cities have tended to result in some abandonment of rural

crossroads cheese factories, modifying the landscape in detail without affecting the regional character. Recent trends within the industry itself in the Dodge region have been toward marked diversification in the kind of cheese manufactured, for at one stage of its development the region specialized almost entirely in brick cheese.

V. C. FINCH.

Landform Description Based on Topographic Quadrangles.

Suggestions for promoting unity of method in describing landforms and for facilitating their comparison by applying certain measurements to the features shown in the standard quadrangles of the United States Geological Survey.

H. R. FRIIS. (Introduced by W. L. G. Joerg.)

A Series of Population Dot Maps of Colonial America.

The history of the diffusion of population and attendant patterns of settlement in the United States is a chronicle of an ever changing, westward moving frontier; the inland fringe of a growing human tide whose energies were directed toward one principal end—the acquisition and exploitation of land, more land. By their energies forests were cleared, recently gained land was cultivated, mineral resources were tapped, avenues of transportation and communication were constructed, and, most significant of all, a fast growing population set up permanent homes. The result was a man-modified landscape.

Probably the most convenient and lucid medium by which to portray the diffusion of population and the attendant patterns of settlement is cartography, employing the dot method of selected periods. There is a surprising paucity of maps of this nature, particularly for the Colonial Era. This paucity suggests the need for an historical-geographic approach through cartographic media.

Preliminary to and basic in such a cartographic presentation must be a judicious examination and compilation of statistical data. For the Colonial Era this is particularly significant. In this paper the preliminary investigations carried out are discussed under: (1) sources of data, (2) mode of occurrence of data, (3) inconsistencies in data, and (4) evaluation of data.

The method of construction of the population maps for the periods 1625 to 1790 is discussed. This includes: (1) construction of base maps indicating boundaries of land grants, and provincial and minor civil divisions boundaries, (2) experimentation to the end of selection of the size and value of dot to be used, and (3) technique used in plotting the statistical data.

Using the maps of distribution of population as media, an interpretation is made of certain of the salient aspects of settlement. This includes: (1) the frontier as a line and as a process, (2) the urban and the rural population, and (3) patterns of distribution of population. (Exhibit.)

REUEL B. FROST. (Introduced by George D. Hubbard.)

Pattern of Population Distribution on the Lake Plain of Northern Ohio.

The subject of population distribution in Ohio has been adequately covered for the state as a whole by Dr. Guy-Harold Smith. This paper deals only with the Lake Plain of Northern Ohio west of Cleveland.

When the scale of any map is increased, it is possible to show more localized details and closer study is, therefore, possible. Thus magnified a map of the population distribution on the Lake Plain shows certain well-defined patterns present, but not readily recognizable on a map of smaller scale.

On the Lake Plain are shown, (1) a group of well-known port towns and cities, including the largest ones in Northern Ohio, located on Lake Erie; (2) another group of smaller cities and towns is located along the crests of the three most prominent and continuous beach ridges; and (3) the smaller towns and villages, mostly agricultural, scattered over the beds of the proglacial lakes Maumee, Whittlesey, and Warren.

Not infrequently the shape of the town or village is related to these beach ridges. Long arms of suburban populations extend along the ridges as well as along the present shoreline of Lake Erie.

Dispersed settlements on the Lake Plain are of two kinds, (a) those located near enough to the ridges to gain, by purchase or exchange, a frontage on them, and (b) those located too far from the ridges for residence with reference to them to be practical. Lot lines show that the early surveyors of the Connecticut Western Reserve located land with reference to the major landforms, such as the lower portions of the streams and the present Lake Erie shoreline, but no such orientation was made with reference to the beach ridges. Subsequent development has led to numerous changes in land ownership in order to give residents a building site on the sandy, well-drained and easily excavated ridge slopes.

AELRED J. GRAY. (Introduced by G. Donald Hudson.)

Land Use Aspects of Reservoir Problems.

Paper No. 2 of a series of seven relating to river development in the Knoxville-Chattanooga area.

One of the problems resulting from the creation of a reservoir arises from the removal of part of the existing regional agricultural resource base.

This problem has three aspects: (1) the significance of the reduction in the total agricultural resource base, (2) the effects of the displacement of land on the regional farm economy, and (3) the displacement of population and the accompanying problem of relocation.

The projects proposed for the stretch of the river between Knoxville and Chattanooga will remove land from 10 counties. Most of this land lies in the Valley of East Tennessee. Within this area the basic patterns of land qualities and land uses are intimately associated with the distribution of ridges and valleys.

The effects of reservoir construction are largely dependent upon the type of land removed from agricultural use. To illustrate, Chickamauga Dam will take approximately 59,000 acres out of private use. Even considering the higher productivity of the bottoms which make up 40% of the land to be flooded, reservoir purchases will reduce the resource base of the five counties adjoining the reservoir by only approximately 4%.

Furthermore, within recent years, the corn, small grains, and forage crops grown on the bottoms, the most productive portion of the flooded land, have changed from feed to cash crops as improved transportation facilities have broadened market possibilities. Consequently, lands removed are of lessening importance to the local farm economy.

If experiences in other reservoir areas hold, the 400 farm families displaced by Chickamauga Reservoir will merely push back onto land adjacent to the reservoir—in this case to land that is, to a large extent, cherty dolomite ridgeland already overpopulated. To determine the types of land most suitable for relocation, studies were made which correlated land classification data with data covering the degree of success of farmers displaced by other reservoirs. By projecting findings from these studies to the area adjacent to Chickamauga Reservoir, it has been possible to delimit areas in which displaced families should be encouraged to relocate.

WILLIAM H. HOBBS.

James Weddell Revealed as a Fake Explorer of the Antarctic.

The British Antarctic explorer, James Weddell of the Royal Navy, has generally been credited with preparing in 1824, as a result of his own observations, an original and detailed map of the South Shetland Islands; and, further, with carrying out one of the most remarkable exploring cruises of all history. This cruise, made in a sailing vessel in a direction southward between the fortieth and fiftieth meridians, was alleged to be to the far southern latitude of $74^{\circ} 15'$. This is six degrees of latitude farther than anyone has ever gone on such a course either before or since, even with the aid of power-propelled vessels.

A careful study of the subject has shown that Weddell was never on the south side of the island groups, and generally not within a distance of twenty-five miles of their northern shores. His map was copied, with names of nearly all features altered, from the suppressed and generally inaccessible map by the American explorer, Palmer, and the English explorer, Powell. This map had been made two years earlier, and a single copy today exists in Great Britain in the collections at the Hydrographic Office of the British Admiralty. On Weddell's map there appeared also an imaginary Antarctic land which was designated "Trinity Land," though the map from which he had copied had Palmer's Land upon it based on Captain N. B. Palmer's discoveries made in 1820.

The sea which Weddell claimed to have penetrated *in open water* near its central axis to a point six degrees farther than anyone has gone either before or since, he named "Sea of King George the Fourth, Navigable." This was later renamed by the British Admiralty Weddell Sea, and is perpetually covered by dense pack ice, the most formidable mass of pack which is anywhere known, and now recognized as wholly unnavigable. It was in this mass of pack ice that Filchner's *Gauss* and Shackleton's *Endurance* were beset and drifted, the latter to be crushed and sunk. The narrative by Weddell has all the life and color which has characterized that by a notorious explorer within the opposite polar region. Both are alike fiction. Unlike his later imitator, Weddell "got away with it," and thanks to the British Admiralty his name has since been made known by that of a large feature of our planet.

ROBERT M. HOWES. (Introduced by G. Donald Hudson.)

Recreational Opportunities Arising from Reservoir Construction.

Paper No. 4 of a series of seven relating to river development in the Knoxville-Chattanooga area.

Recent activities in the field of government and economics—not to mention literature and drama—have focused the attention of the nation on the South and the Tennessee Valley. As a result, literally hundreds of thousands of tourists have been prompted to make these areas new travel objectives. They have discovered in the Tennessee Valley a new vacation-land endowed with mountain scenery, luxuriant forests, tumbling streams, and an inviting climate. Only the natural lakes with which more northerly portions of the continent are endowed are absent from an otherwise complete roster of recreational resources. The reservoirs now being constructed by TVA as part of its river-development program assume, therefore, a special significance for recreational development—a significance which is added to their already multiple purposes of navigation, flood control, and power.

The Authority recognized this recreational significance and has recognized as well that in the Valley as a whole recreation may achieve the status of a major industry. It has therefore made studies not only of individual reservoirs, but of the region as a whole. The Authority's recreation studies have been limited to surveys, plans, and demonstrations. Surveys and plans have been conducted both for individual reservoirs and for the region, but demonstrations have been confined to developments on reservoir shorelands. Except in the matter of scale, regional and reservoir studies are similar in nature. Both include inventories of the potentialities for recreational development in the area under consideration. These potentialities are compared with those of related areas. Detailed studies are made for specific sites of unusual interest, and finally in the case of reservoirs recommendations for recreational land uses are integrated with recommendations for other land uses to form a general land use plan. For illustrative purposes this paper considers in detail recreational studies made by the Land Planning Division in the vicinity of Chickamauga Lake, which is located in the Knoxville-Chattanooga area.

G. DONALD HUDSON.

The Setting for the Work of the Land Planning Division, Tennessee Valley Authority.

Paper No. 1 of a series of seven relating to river development in the Knoxville-Chattanooga area.

The Tennessee Valley Authority is another chapter in a century of interest in the utilization of a natural resource—the Tennessee River and its Basin. Drainage into a common river system gives the 41,000 square miles of the Tennessee Valley area its regional unity. Two and one-quarter million people—nearly 100 per cent native born and 90 per cent white—live and make their living in this Valley. Farming is the dominant way of life; coal mining is localized on the Cumberland Plateau; manufacturing is chiefly concentrated in a few urban centers. Economic returns from these occupations constitute a major problem.

Four years ago the Authority came into this diverse region to set up a program varied to meet diversity, but unified to meet the single objective of regional development. The nature of the program calls for two lines of action: One concerns river development—the construction of dams and reservoirs; the other relates to broad regional problems. The work of the Land Planning Division, one of three divisions in the Department of Regional Planning Studies, has been organized also along the lines of river development and regional problems. These two lines of work are not mutually exclusive. Regional materials are utilized in the treatment of problems

relating to construction, whereas findings growing out of reservoir studies play an important part in regional understandings.

Studies relating to river development have been selected as the major theme of the series of papers that this paper introduces, largely because these studies offer concise examples of TVA projects in their early stages—stages which are dominated by activities of a research and planning nature—and projects in their later stages in which the results of research and planning are put into effect.

Using the river development projects between Knoxville and Chattanooga for illustrative purposes, the first four papers discuss in turn the effects of reservoir construction on the land and land-use conditions, local economic units, opportunities for recreational developments, and how the findings from these studies are utilized in the appraisal of projects and in the planning of readjustments. The next paper describes the procedure used in determining purchase boundaries and the use of reservoir properties after they have been purchased. The last paper summarizes some of the regional problems and needs of the Tennessee Basin and lays the groundwork for a later treatment of the Tennessee Valley as a regional unit.

ELLSWORTH HUNTINGTON.

Geography and History.

The relation between geography and history will become clear only when there is a careful separation between temporary and local influences, on the one hand, and permanent and widespread influences on the other hand. It is easy to detect temporary influences such as that of the cold winter on Napoleon's invasion of Russia, or the cuestas around Paris on the advance of the Germans during the World War. It is much more difficult to analyze the effect of poor soil, for example, in producing poverty, retarding progress, and creating inefficiency and discontent. Still greater difficulty arises when an attempt is made to analyze the effect of such conditions upon migrations and upon national character and ambitions. Much has been written about the effect of minerals upon international relations, but even in this most familiar aspect of geographical influences we are still far from understanding how much is due to minerals and how much to the other factors, both environmental and cultural. In the present paper an attempt is made to analyze the main types of influences, and then to use the soils of Iowa, and other places as an example of one way in which the permanent influence of a geographic factor upon history can be investigated.

MARK JEFFERSON.

The Law of Primate Cities.

In most important countries the largest city is two or more times as large as the next largest city, and other cities differ in size by much smaller numbers.

All great cities have, as important factors in their growth the productivity of their region and its extent, as well as their situation with regard to the chief lines of movement of internal and external commerce.

Cities generously endowed with these two elements of growth are likely to be very great cities. New development of resources or acquisition of new productive areas, or new development of transportation lines that favor them more than other cities are likely to cause them a sudden increment of population.

Another very important factor in a great city's growth is its primacy among the great cities of the land—its attainment of distinctly greater number of inhabitants. The moment that happens the force of primacy, which it alone possesses, causes it to take on a rate of growth so much larger than that of any other city in the region that it shoots up to a magnitude out of the class of any rival city. *E.g.*, at no time in the past eighty years has any city in the United States had more than half as large a population as the city of New York.

STEPHEN B. JONES.

The Weather Element in a Trade Wind Climate, Illustrated by Hawaii.

Published in full in this issue.

HAROLD S. KEMP.

Food for Thought.

The world and its wife eats what it has. Economically advanced regions import both luxuries and necessities in food, but even in the most sophisticated districts relics of local dependence testify to an era of simple living attuned to the resources of the neighborhood. "Regional dishes" may belong to a nation or to a valley, but they are the more or less complex and artistic treatments or blendings of familiar materials.

New England dishes are as numerous as they are old. Some have a wide appeal, either through taste or cheapness, and Boston baked beans and brown bread, carried westward by early settlers, are now nationally known. New England dishes reflect the climate that made root-crops and hardy vegetables at home, and speak of hard times and the thrift that becomes inherent in regions used to hard times; of animals that could be raised, of fish in the sea, and of harbors that opened the region to sea trade.

New England's early established commerce is responsible for the colonial use of foreign commodities when most of the world ate only indigenous

foods. The destination of boats sent overseas was conditioned by their wares. Where New Englanders could sell fish, barrel staves, and ice, they found molasses, chocolate, and spices—still important in Boston trade and manufactures.

The "New England boiled dinner" speaks of roots and hardy vegetables cooked with salt beef, cured for sailor fare. Brown bread and Indian pudding are made of local cornmeal sweetened with West Indies molasses and seasoned with spices. Boston baked beans are "different" because molasses and spice suggested the glorification of beans, one of the most acceptable local crops, baked with sailors' salt pork.

Codfish cakes combine salt fish (a coastal product for hinterland and export) and another underground vegetable in a region where late Spring and early Fall frosts are common. To Fall frosts may be traced pickles from tomatoes picked green to save them. Pickled beets, the other local relish in general use, are merely another hardy root.

Nowhere else in America are fish so generally eaten. They are procured from cold northern waters, as are the lobsters and clams that make "shore dinners" famous.

If Indians blended beans and corn in succotash as the first regional dish, clam chowder is perhaps the best combination of local produce the whites created. Clams from tidal beaches add inimitable flavor to boiled potatoes, while onions from drained glacial lakebottoms, pepper from Boston spice mills, and salt pork from the sailors' store need only milk from stony hill pastures to make a treat and a meal.

To this list might be added apple pan-dowdy, hasty pudding, samp, cods' cheeks and tongues, cocoa-shell tea, molasses-and-ginger haymakers' drink, pickled limes, and others, all true expressions of New England's geography.

MARY J. LANIER. (Introduced by Derwent Whittlesey.)

Early Boston.

Within three decades of its founding in 1630, Boston had grown from an infant settlement on the edge of the wilderness to a prosperous maritime town, the wharves and warehouses crowded upon its waterfront testifying to the supremacy of its commercial interests.

Before the close of the first decade, Boston had become the market town for the rapidly developing agricultural and pastoral communities upon the neighboring lowland. During this period, ship after ship anchored before Boston, landing there passengers, livestock, and supplies of various kinds. Many of the newcomers settled in Boston or in neighboring towns; others established new settlements where land was more abundant. This growth of population in the tributary area gave an increasingly large group depen-

dent upon the Boston market. Boston merchants imported in English ships commodities needed by this rapidly growing population but developed no adequate export trade, money spent by the incoming settlers enabling the merchants to meet their bills in England.

Within the next two decades an important export trade was developed. This development, however, was preceded by a severe business depression in the early 40's, brought about by the sudden cessation of that immigration upon which the prosperity of the first decade largely had been built. Few ships from abroad now came into the Bay; there was little market for surplus grain and stock; manufactured goods became scarce; the merchants had not means to replenish their stock or to meet their obligations abroad. Prompt measures were taken to meet this crisis. Boston merchants set to work to provide ships and to find cargoes with which to freight the outgoing vessels. These needs stimulated the development of the fisheries and the exploitation of the forest resources of the colony, and in a short time trade was reestablished on a sounder basis than in the first decade.

Assurance of an outlet for surplus products greatly stimulated economic activities in the tributary area and strengthened the position of Boston as market town. The building of fishing boats and trading vessels, the pursuit of the fisheries, the assembling and preparation for export of primary materials produced in near-by areas gave employment to many inhabitants of the town.

By 1660 Boston held unquestioned leadership as an importing and exporting center for New England. Its merchants had a lucrative trade with other English continental possessions, with the West Indies and with Mediterranean Europe. The commodities thus secured enabled them to supply the local markets, as well as to pay for manufactured goods imported from England.

Thus early were laid the foundations of those commercial activities which were to dominate the life of the people of Boston for at least two centuries.

GEORGE M. McBRIDE.

Agricultural Indian Communities of Highland Guatemala.

Indians form some 75 per cent of the population of Guatemala. Most of these Indians live in the highland at elevations of from 4,000 to 7,000 feet. This element of the population is important partly because of its numbers, partly because it represents apparently the parent stock from which the Mayas of Yucatan sprang, and preserves much of the culture out of which grew the high civilization of the Yucatan Empires. These Indians are predominantly agriculturists, cultivating principally corn and beans,

mainly as subsistence crops. Their methods of farming preserve more of the pre-Columbian than is seen elsewhere in America. Their social life and organization also are very largely those of pre-Conquest days. To understand their agriculture and their social institutions it is necessary to know their habitat.

The elevation of the plateau lifts it out of much of the disease characteristic of the tropics. Numerous springs and streams provide relatively safe water supplies. Over most of the plateau is spread a thick mantle of volcanic ash providing an excellent, easily tillable soil whose fertility is periodically renewed by light deposits of volcanic dust. The rainfall is adequate (40-50 inches in Guatemala City) and comes mostly in the warmer season. Temperatures vary little from season to season, the warmest month in Guatemala City (May) showing 67° F., the coolest month (January) showing 60° F. Such temperatures are conducive to greater activity than is generally found in the tropics, at the same time making imperative some provision for shelter and clothing. Daily range is greater than the seasonal, a difference of 27° F. being not uncommon at any time of the year. Freezing temperatures are extremely rare except in the higher districts where crops occasionally suffer from frost. A six or seven month rainless period has somewhat the effect of winter in mid-latitudes in making necessary seasonal activity, planning and forethought. Both air and water drainage are good. The volcanic plateau is profoundly dissected, deep, steeply cut barrancas alternating with nearly flat inter-canyon spaces. The unevenness of the land is further accentuated by numerous volcanic cones that rise above the plateau. This broken topography results in much hillside cultivation. It also divides the tillable land into many small areas separated from each other by barranca or ridge. As a consequence of this distribution of arable soil, the population is sharply divided into isolated communities. Each community has certain distinctive characteristics of costume, language, secondary industries and social organization. The life of each community is sharply bounded by its own territorial limits. There is little in the way of national, racial, tribal, social, or economic ties binding the communities together. Each is, to an unusual degree, an independent unit.

History seems to indicate that in the past, as at present, the Indian agricultural community has constituted the unit of population and that about the individual community has centered the life of the region.

PEVERIL MEIGS, 3RD. (Introduced by R. J. Russell.)

Regional Trends in California Orchards.

To retain its significance for as long a time as possible, a regional culturogeographical study should include not only the analysis of present and

past landscapes but also the detection of landscape trends. This study, whether dealing with population, land utilization, erosion, or other element, may be called "dynamic geography."

The paper uses a statistical technique for the recognition and analysis of land utilization trends by means of data obtainable from a single field study independent of statistics of previous years. The method is similar to that of the ecologist who, by noting the relative scarcity or abundance of young growth at the edge of a forest, can learn whether the forest is advancing or receding. In the United States, field surveys have accumulated statistics by counties on the number or acreage of bearing and of non-bearing orchard trees and vines. The United States Census provides data for a few varieties, and a recent agricultural survey for a large number of varieties in California.

The percentage of non-bearing trees gives a clue to the activity of planting, since the non-bearing trees correspond to the young growth of the ecologist's forest margin. With careful evaluation of the "dynamic ratio" (number of non-bearing trees divided by total number of trees), it should be possible to distinguish between localities of progressive, regressive, and stable conditions for each type of orchard. A striking regional trend is indicated, for example, by the dynamic ratios of grapefruit in 1935:

Florida	9%
Texas	35%
Arizona	29%
California	31%

In plants ranging through widely different climatic or edaphic regions, with resulting differences in life periods, the dynamic ratio is not sufficient to show relative trends. If, for example, peach trees come into bearing after 4 years, and have a bearing life of 16 years in New York and 3 years in Louisiana, a dynamic ratio of 20% would indicate stability in New York, while stability in Louisiana would mean a ratio of 59%. Full use of the dynamic ratio necessitates some knowledge of regional differences in life histories of trees. This paper considers methods of obtaining life histories, including field investigation. For example: a large dynamic ratio may result from replacements following frost.

Maps have been made of distribution of dynamic ratios of certain fruits throughout the United States; on the basis of diagnoses from them, maps were made of key states, by counties, particularly for California. Field studies and correspondence with state agricultural authorities were used in evaluating and mapping the significance of the regional differences in dynamic ratio.

It is likely that the dynamic ratio technique can be fruitfully used in the

field anywhere, not only for orchards, but also for other cultural elements, such as houses.

HAROLD V. MILLER. (Introduced by G. Donald Hudson.)

Effects of Reservoir Construction on Local Economic Units.

Paper No. 3 of a series of seven relating to river development in the Knoxville-Chattanooga area.

Local economic units are affected by the displacement of land and people caused by the construction of dams and reservoirs, major elements in the river-development program of the Tennessee Valley Authority. To analyze and report on the nature and magnitude of these effects is a duty of the Land Planning Division.

Retail trade in its composite was chosen as the most pertinent and usable criterion for delimiting local economic units. Boundaries for each retail trade area were drawn on the basis of field interviews. This method produced single-line boundaries which avoided overlaps and at the same time accounted for all of the area studied. The Sale Creek economic unit as delimited by the trade area study was found to have 66 square miles and 1900 people. One-third of the area and 88 per cent of the people are located in the valley between the Cumberland Plateau and the river, the area in which reservoir inundation will occur.

Inundation by the Chickamauga Reservoir will remove from the Sale Creek trade area one-sixth of its land used for agriculture, but at the same time will take about half of its better agricultural land. Only 7 per cent of the trade area's population will be forced to relocate, representing a possible maximum of 12 per cent of Sale Creek's gross sales in retail trade.

Analyses of the Sale Creek merchants' stocks and investments indicated that a slight temporary retrenchment on the part of store-owners would not impair their continued operation. Analyses of Sale Creek's competitive position indicated that the town should be able to continue to function, located as it is on a railroad, a through highway, and at a focal point of local roads. Furthermore, possibilities for additional profit and expansion in Sale Creek lie in developments in manufacturing and in recreational activities related to the creation of Chickamauga Lake.

The analysis of retail trade which formed the basis for this appraisal of reservoir effects on local economic units is now being carried on over much of the Valley and is contributing in various ways to regional studies. Results from these studies can be presented at some future date when the surveys upon which they are based are more nearly complete.

O. M. MILLER.

The Present Status of Photogrammetry.

The problems of photogrammetry may be grouped under two main headings: (1) those connected with the production of photographs for portraying perspective accurately and economically (as, for example, problems of constructing precise cameras, wide-angle lenses, and suitable films, papers, and emulsions); and (2) those connected with methods for converting the perspective into maps. In the second classification, though the main problem is solved theoretically, many developments are taking place in technique.

There is a wide divergence of opinion as to how far photogrammetry can take the place of ground surveying. Some hold that except in special circumstances it is merely an auxiliary to ground surveying, useful for obtaining detail; others claim that it is capable of taking the place of most ground-surveying techniques with the principal exceptions of geodetic triangulation and precise levelling.

The paper describes non-technically what some of the problems are and how they are being handled by different mapping organizations in the United States and abroad.

LOIS OLSON. (Introduced by C. W. Thornthwaite.)

The History of Erosion in the Ancient World.

Methods of increasing the world's food supply are generally regarded as agricultural progress but they are also stages in the development of land exploitation, which is probably the basic cause of soil erosion. Undue increase in the size of herds causes the deterioration of pastures, the opening of new lands may be accompanied by the introduction of agriculture into areas not climatically or physiographically suited to farming, and even the adoption of such accepted practices as clean cultivation or the plowing of straight furrows has increased erosion on sloping lands. From the earliest historical times to the present it has been found that agricultural advance into new areas or the abandoning of engineering works, such as terraces, reservoirs, or irrigation canals, has been accompanied by accelerated erosion. For example, with the deforestation of the Assyrian highlands and the spread of irrigation northward in Mesopotamia, erosion increased and was accompanied by sedimentation downstream, which augmented the difficulty of irrigation, caused land abandonment, and accelerated wind erosion. In both Assyria and north Africa the need for increased food production resulted in the outward spread of dry farming towards the desert margins, where the soil was particularly susceptible to blowing. Intensive agriculture and the use of irrigated terraces were highly developed in the countries at the eastern end of the Mediterranean, Phoenicia in particular, and from there spread to Greece, Carthage, Spain, and Italy. The

Romans, while adopting the earlier practices, adapted them to local environmental conditions. The techniques developed were disseminated throughout the Empire. During the Middle Ages records of the Roman methods of cultivation were preserved by the writings of the Arabs and in the monastery libraries of northern Europe. With the beginning of the agricultural revolution Roman practices were revived and have since been applied in all parts of the world where European influence has been dominant. This is in part responsible for the world-wide development of land exploitation. Current efforts to restore to the fields of Europe their former productivity and to maintain permanent agriculture in the new world, in the face of accelerated erosion, mark the beginning of a new agricultural revolution in which erosion and its control play a major role.

RAFAEL PICÓ. (Introduced by Clarence F. Jones.)

Farm Types in Puerto Rico.

Farm organization and tenure are of vital importance to Puerto Rico, where a population of 500 to the square mile depends almost entirely on agriculture. The micro-study of farm types reveals the possibility of tracing farm characteristics to physical and economic factors. Three leading types of farming dominate in the Island's agricultural economy: sugar-cane, coffee, and tobacco.

Sugar-cane farms, the most important of all, cover the level coastal lowlands of fertile alluvial or limestone soils, with abundant moisture from precipitation or irrigation. Most of the rich cane lands are controlled by 41 mills, representing 30 corporate or individual owners. Their farms include about 50% of the total cane land and produce 60% of the sugar-cane raised in the island. Of these producers, four absentee-owned sugar corporations are as important as the other 26 units combined. The average area controlled by each of the four corporations is 40,000 acres, half planted to sugar-cane. To correct absentee-ownership and land concentration, the Puerto Rico Reconstruction Administration in 1935 bought the Lafayette sugar mill with its 10,000 acres of land. Most of this area has been subdivided into units of less than 500 acres, operated by the agricultural laborers united in a number of cooperatives.

Although less important than formerly, coffee farming is still significant; for one-fifth of the farms it is the main source of income. Of the total cropland area 70% is cultivated by owners, whereas in the sugar-cane farms the proportion is 31%. A typical coffee farm shows more diversity in land utilization than a sugar plantation. Coffee normally covers from one-third to one-half of the farm, intercultivated with bananas and oranges in addition to shade trees. Due to difficulties in marketing coffee, the farmer, to

supplement his main crop, has turned to cultivating plantains, limes, vanilla, sugar-cane, and additional bananas.

Unlimited entrance to the protected United States market has stimulated the tobacco industry, only to a less extent than sugar-cane production. The typical tobacco farm is a diversified, small farm; the smallest unit producing an important export crop in Puerto Rico. The average size fluctuates from 14 to 63 acres, a marked contrast with the average sugar-cane or coffee farm. A fairly large proportion is composed of tenants or share-croppers. There is practically no absenteeism in the agricultural phase of the tobacco industry now that the P.R.R.A. has bought the 4,400-acre farm belonging to the absentee-owned company operating in the La Plata Valley, and has subdivided it into 5- or 6-acre homesteads growing tobacco and subsistence crops. Usually, only one-fourth of the cropland is planted to tobacco, although it constitutes 90% of the total farm sales. Corn, bananas, plantains, beans, and root-crops are also grown. Thus, tobacco farming has many desirable features—native ownership, small farms, and diversified utilization—which are stressed as constituting the backbone of a farming community in a densely populated country.

ROBERT S. PLATT.

British Guiana, mit Anmerkungen.

An example of microchoric study in pure, regional, human geography, concerned with landscape, areal association of observable phenomena, pattern of terrene occupance, and regional units both of static areal homogeneity and dynamic areal organization.

Attention is focused on two plantations on the coast of British Guiana; each a consolidation of Dutch colonial plantations built by slave labor; each protected by front and back dams against salt and fresh water floods; in each a double system of canals, one set for boats and water supply, another set for drainage; in each a middle body of intensively cultivated land between front and back strips of idle land; in one plantation, sugar-cane grown under irrigation in spite of a rainy low latitude type of climate; in the other plantation coconuts grown under irrigation in clay soil by negro labor, and rice grown in the oldest and newest fields by East Indian labor.

Comparing the distinctive characteristics of the plantations with the general characteristics ascribed to the equatorial areas in which they lie it appears that broad regional generalizations can be relied upon for only rough preliminary geographic knowledge of the area. Field reconnaissance by air along the coast and library reconnaissance in the history of Guiana show that the plantations are not an exotic phenomenon but a normal fea-

ture of a coherent district having a consistent place in the intricate geographic pattern of South America.

The conclusion is *mit Anmerkungen* apropos of two articles on American geography which have appeared during the past year in German Zeitschriften.

SIDMAN P. POOLE. (Introduced by Harlan H. Barrows.)

A Geographic Reconnaissance in Northern Mayaland.

This paper summarizes some of the results of an expedition, made early in 1938, to the Mayan cities of northern Yucatan. The objective of the expedition was to make an environmental study of the urban patterns of some of the ruined sites, particularly in relation to water sources, food supply, building materials and routes of travel.

The culture of the Mayan Indians was complex. It seems to have been essentially an urban civilization based upon agriculture. Corn, then as now, was the chief crop. Domestic animals were unknown and hand tools of wood, bone, and stone were the only ones employed. Scores of city sites lie buried in the Yucatan bush, and only a few of them, such as Chichen, Itza, and Uxmal, have been even partly cleared and excavated.

These cities were all located close to sinkholes or cenotes, some of which contained the only available water supply. Several of these were noted near Coba. The terraces, pyramids, and temples were constructed of the soft, porous limestone everywhere abundant. Numerous shallow quarries seem to have been the rule, and traces of some of them were found. Surfaced roads, several feet above the general land level, connected the chief cities. Travelers, traders, and religious pilgrims all made use of these causeways and water-bearing cenotes are scattered along them.

There is a similarity in the pattern of all the Mayan cities. The remaining buildings, temples, terraces, and pyramids are grouped around "plazas." These squares seem to have been the "commercial cores," the centers for trade and for public or religious ceremonies. The causeways radiate in straight lines from these centers. Such a causeway was discovered that led south from Coba; it may have extended to the Old Empire area in Guatemala. Only Tulum, and perhaps a few other cities, show definite traces of military works, such as walls. Good defensive sites were lacking in Yucatan and it is probable that the terraced temples served at times in this role.

In the bush around the "plazas" were the oval thatched huts of the people. Footpaths formed the communication system. The milpa system of agriculture, still practiced, necessitated frequent changes in home sites. Many small mounds and rectangles of cut stone dotting the jungle around

Coba, Chichen, Itza, and Uxmal are evidence of a considerable population, but it may have been less at any time than the number of mounds would indicate.

Solution of many problems in this land of "the deer and turkey" can be aided by the geographer's fieldwork, his viewpoints, and his methods.

MALCOLM J. PROUDFOOT. (Introduced by C. E. Batschelet.)

Determining the Minor Civil Division Areas of the United States.

The Census Bureau is determining the minor civil division areas of the United States. This is part of a program which gave a map basis for each census, a set of minor civil division state outline maps for the Census of 1930, and plans a detailed United States population density map and statistical atlas for the Census of 1940. These areas will give sixteen times the refinement now available for county statistics.

The plan calls for a threefold adjustment of minor civil division areas to predetermined county areas, of county areas to predetermined state areas, and of state areas to a predetermined total area for the United States. Area totals determined from United States Geological Survey quadrangles will be used without adjustment.

Smithsonian Geographical Tables, giving the area of square degrees and minute portions, are used to ascertain state, county and minor civil division areas. Table values are listed for complete quadrilaterals and to these are added the areas of boundary fragments obtained by adjusting planimeter measurements on a percentage basis to the table value for the entire quadrilateral. General Land Office plat maps are searched and the desired acreages transcribed and totalled. Finally, for a number of states, planimeter measurement adjusted to known areas is most suitable for obtaining reasonably accurate minor civil division and county areas.

The following map sources are being employed: 1:500,000 United States aeronautical charts of the U. S. Coast & Geodetic Survey; standard U. S. Geological Survey quadrangles complete for certain states and separate counties; the 1:500,000 and 1:250,000 state-county maps of the U. S. G. S.; the plat maps of the General Land Office; and county maps of State Highway Departments, the Bureau of Chemistry & Soils, the Post Office Department, state geological and geodetic surveys, commercial concerns and engineers.

Changes will result from a new gross area including Long Island Sound, Delaware and Chesapeake Bays, and the Juan de Fuca Sound and the Great Lakes to the Canadian Boundary. Recent boundary decisions will introduce area change. Finally, nearly five decades of mapping progress has been made since the basic measurement of the United States. There-

fore, it is probable that in the majority of cases the state and county areas will differ from those previously released. Despite progress, the difficulty in determining accurate areas is not method, but the varied quality of the map record. No results can be more accurate than this record. It is assumed that the best method is being used.

C. E. RAMSER. (Introduced by Helen M. Strong.)

Research Studies in Hydrology with Special Reference to Soil Conservation and Flood Control.

The paper describes the nature and scope of the research work being carried on by the Section of Watershed and Hydrologic Studies of the Division of Research of the Soil Conservation Service. The research work of this Section is devoted mainly to investigations of the effect of land-use and conservation practices on flood flows and on soil and water conservation. Investigations are under way at three major research watersheds located in the North Appalachian Region of eastern Ohio, the Black Lands of Texas, and the Central Great Plains of Nebraska. In addition, installations for the measurement of rainfall and runoff have been established on 80 small watersheds over the United States. The effect of improved land-use practices is to be determined by comparison of measurements on the watersheds in their present state and prevailing land-use practices with measurements on the same watersheds after soil and water conservation practices have been established. A general description of the extent and diversity of observations and measurements is given, which, in addition to their relation to the problems confronting the Soil Conservation Service, indicates their value to the science of hydrology.

(Exhibit.)

VICTOR ROTERUS. (Introduced by G. Donald Hudson.)

Meeting Regional Problems and Needs.

Paper No. 7 of a series of seven relating to river development in the Knoxville-Chattanooga area.

Besides providing for the river development program, the Act creating the Tennessee Valley Authority charges the Authority with a broader responsibility of planning for and assisting in the general development of the watershed region. When TVA was created, there existed no surveys or data on the broader aspects of the region comparable to those of the Army engineers on river development. Hence, before a definite and complete program of regional planning effort could be formulated, a great deal of exploratory work had to be done.

Research involving analyses of rural land classification survey data and

of the relationships of the major livelihood activities of the Basin has led to a clarification of regional planning goals. These studies show the chief economic need of the Basin to be the proper expansion of employment opportunities in the industries and services other than agriculture. The reasoning behind this conclusion is as follows. There is an obvious need in the Basin for widespread adoption of soil-conserving practices. The practical success of a soil-conservation program depends on its ability to meet the farmer's immediate income needs. These needs are particularly acute and compelling in the Basin since income from farming is low compared to some of the other major occupations in the Basin and even when compared with farming in the remainder of the country. However, sound, long-term solutions to the improvement of the agricultural resource base and to agricultural income in some respects run counter to immediate farmer relief since less intensive uses of the land are implicit in some phases of soil conservation. The more stringent measures such as rural zoning or public acquisition of land, despite their long-run virtues, displace agricultural population and increase the burden on the remaining agricultural lands. It would seem, obvious, therefore, that only part of the problem of reconciling soil-conserving practices with a farm income at least equal to that received under destructive practices can be met within the domain of agriculture itself. A program of soil conservation and improved income must be accompanied by a program augmenting opportunities for employment in the industries and services other than agriculture.

Aside from its long-range measures of soil conservation, reforestation, agricultural processing experimentation, TVA has had immediately favorable effects on the expansion of employment opportunities in manufacturing and recreation. Research is aiding the growth of both these major industries, and studies with respect to proper guidance of this expansion are underway.

The completion of TVA's river development program will meet many of the Basin's specific needs and will aid adjustment to the Basin's broader regional problems. Eventual adjustment, however, will be at best a slow process demanding concerted and purposeful efforts by all public and private agencies.

JOSEPH A. RUSSELL. (Introduced by George B. Cressey.)

Some Applications of Aerial Photography to Geographic Inventory.

Vertical aerial photographs contain a wealth of geographic inventory data, some of which is directly interpretable from the photographs, and some of which must be translated into more understandable terms before it can be used. Keys or legends of two types are of use in making this

latter type of information available: first, keys based upon field correlation of phenomena with photographic tones and textures, and, second, keys derived from a study of shadows, shapes, and surrounding or associated objects which hint at the nature and function of the image under consideration. The first type are named direct keys, and the second type associative keys.

It is believed that through the establishment of direct regional keys to the identification of the natural phenomena by checking the photographs in the field, and by setting up associative keys to the cultural elements of the landscape it is possible to extend the determinations which are established in the field to a much wider area than is actually covered in the field. Such technique would reduce the time for regional inventory, and would therefore reduce the cost of the project. It is not proposed that the interpretation of aerial photographs will ever entirely supplant field work, but will become a major supplementary technique.

The keys to the natural phenomena are based on one assumption: that similar phenomena will photograph similarly, and that therefore similar vegetation associations (for instance) will display a like photographic tone and texture which will be distinguishable from that of other stands. Some other natural phenomena such as water and soils are identified in a like manner, while still others: relief, structure, and individual trees, may be identified by their shadows. Most of the cultural elements must be determined by translating surrounding tones and textures into terms of our ground experience so that associations may be established which will identify the object. Many cultural factors may be identified by their shadows. The combination of associative and direct keys makes possible the differentiation of such apparently similar (from the air) buildings as churches, schools, houses, factories, railroad stations; classes of roads and railroads; cropland and pasture land.

These and other keys are defined and illustrated by examples based on field mapping and photograph interpretation in the Upper Peninsula of Michigan and in the vicinity of Syracuse, New York.

Advantages and disadvantages in the use of photographs as tools of geographic inventory as compared with accepted field methods are grouped under the following heads:

1. Types of photographs (quality, altitude, camera, time of year, age).
2. Delimitation of boundaries—advantage to photographs.
3. Determination of the nature of phenomena—advantage to field survey.
4. Possibilities of generalization—advantage to photographs.
5. Speed—advantage to photographs.

6. Cost—advantage to photographs if already flown. Cost usually excessive if necessary to fly large area for this purpose. (Exhibit.)

RICHARD JOEL RUSSELL.

Glacial History from Non-deglaciated Regions.

Davis urged the study of Pleistocene climates through their morphological effects on areas beyond the limits of deglaciation, in such regions as southern Arizona. Daly, Davis, Gilbert, Russell, and others, in pushing investigations in regions as remote as tropical oceans, or in arid continental interiors, have established broad outlines of glacial history as related to swinging levels in Quaternary seas and lakes. The probability seems strong that the advances and retreats of ice-masses may be studied more effectively beyond the limits of deglaciation than within them. Deciphering a record involving both major and minor oscillations in ice-fronts is possibly too complex to be based on the study of glacial landforms alone. More readily read is the somewhat dampened record indicated by terraces of streams entering oceans beyond the limits of ice-cover. These records appear to be consistent.

Terraces in valleys near major deltas are especially well located to preserve records of oscillations in levels of Pleistocene seas, and hence of glacial advances and retreats. Those of Louisiana have been studied in detail. Those of the Rhône and Rhine have been investigated and agree in all essential particulars with the Louisiana study.

Each glacial stage, as evidenced by lower sea-level, was a time of valley intrenchment. Each interglacial stage was a time of valley filling. Intrenchment during each glacial stage left the floodplains of the previous interglacial stage as terraces along the main valleys and their tributaries. Such terraces would present an undecipherable record had not regional uplift taken place. Such uplift was continuous and was associated with regional tilting toward deltas and broad continental shelves. This has differentiated the terraces and has preserved their remnants in chronological sequence from youngest, at the base, to oldest, at the top of the series.

Four interglacial stages appear to have preceded the Recent (which may be best defined as the epoch of coastal drowning now being experienced). The two older interglacial terraces may be separated from the two younger on the basis of coarser valley fill (confusingly indicated in geological literature as Lafayette, Citronelle, etc., in distinction to Columbia, Port Hudson, etc.), wider valleys, (indicating longer periods of ice-cover during the preceding stage of intrenchment), and in the steeper seaward gradients

they present today. The longest break in terrace history occurred between the second and third terraces, as indicated by a more steeply-sloping pair overlying topographically a less steeply-sloping pair. The most intense glaciation preceded the lowest terrace filling, as judged by the greater in-trenchment of valleys at that time. It was not as prolonged as the earlier glaciations, as indicated by narrower valleys and steeper walls. The number of major glacial advances thus appears to be five and these may be grouped into two general glaciations, an earlier, with two advances, and a later, with three.

GUY-HAROLD SMITH.

The Morphometry of Ohio: The Average Slope of the Land.

Among the several elements which constitute the configuration of the land surface, slope is one of the most important. By use of Wentworth's method the average slope of the land for small unit areas can be determined, and from the data thus obtained an isarithmic map of larger areas constructed. This quantitative technique has been applied to Ohio with the following results. In the area once covered by Glacial Lake Maumee and its successors the average slope of the land is less than one per cent. Where the till plain of western Ohio is diversified by a morainic terrain the slope averages less than three per cent. Farther southward toward the Ohio River, the available relief becomes greater and as a consequence the average slope increases to more than five but generally less than ten per cent. The Appalachian Plateau while intricately dissected in the areas adjacent to the Ohio River has been heavily veneered with glacial drift in the north-eastern section of the State. In this glaciated portion of the Plateau the average slope is less than five per cent except in a number of limited areas where post-glacial dissection has greatly increased the local relief. In the unglaciated sections of the Plateau the relative relief varies between 300 and 800 feet and the slope of the land ranges between ten and twenty-five per cent.

J. RUSSELL SMITH.

The Doomed Valley of the Upper Rio Grande—an Example of Regional Suicide.

Over-pasturing on the uplands of New Mexico is causing increased run-off and increased erosion by the streams flowing into the Rio Grande in that state. The detritus is filling the channel of the Rio Grande. This raises the water table in adjacent meadows and demands dikes and expensive drainage, if perchance it can be done at all, and menaces widespread ruin of valley lands by turning them into alkaline marshes.

This is a perfect example of regional suicide and raises two interesting questions:

1. What will become of the valley populations in the not distant future when the valley is no longer tillable?
2. Who is this family that they should be allowed in one generation to ruin land that would support a hundred generations of men in the next 30 centuries?

H. THOMPSON STRAW. (Introduced by P. E. James.)

Land Utilization of the Eastern Highland Rim Plateau of Tennessee.

The Eastern Highland Rim Plateau of Tennessee lies between the Central Basin and the Cumberland Plateau. It is an upland from 25 to 35 miles wide and about 125 miles long which rises to an elevation of about 1300 feet on the western edge and slopes gently to an elevation of 1000 feet on the eastern edge. When viewed in relation to the adjacent regions it is essentially one of transition in elevation, in the fertility of its soils and in the economic and social position of its people.

The level to gently rolling surface of the Plateau represents a stage of peneplanation arrived at during early Tertiary times. On it are exposed rocks mainly of Mississippian age. Those of early Mississippian age which are exposed near the western margin and of which the Ft. Payne chert is an example consist of limestones filled with chert and a porous siliceous cement. Those of a later Mississippian age which are exposed near the eastern part of the plateau and of which St. Louis limestone is an example consist of much purer limestones, usually massive and fine-grained with only relatively few beds of chert.

Most of the soils of the Eastern Highland Rim Plateau are residual. The rivers, for the most part youthful or in the earliest stages of maturity, have during the present cycle deposited almost no alluvium. These residual soils are young enough to derive most of their characteristics from parent material, and hence they are usually related to the underlying strata of rock. Three longitudinal soil belts can be recognized. To the west, developed on the lower Mississippian strata, are the siliceous, rather infertile "Barren-type" soils which range in color from light tan to a light gray that borders on white and are usually filled with chert fragments. Farther to the east and on the upper Mississippian strata are found more fertile limestone soils, usually red to reddish brown. A third soil belt can be recognized lying adjacent to the Cumberland Plateau. Here a mixture of the red clay of the upper Mississippian limestone and of the yellow sand from the Cumberland Plateau, above, is formed.

Less correlation than might be expected exists between the distribution of farmland, improved land, and cropland and this soil pattern. One

reason is that the red soils, although more fertile, erode more readily than the "Barren-type" soils and therefore soil erosion hinders their use just as soil depletion does that of the soils of the Barrens. A more important reason is that in this region, through a lack of educational opportunities and adequate transportation the population has increased beyond the ability of the area to support it. Farms have been cleared, land has been improved, and crops have been planted with little regard to native fertility. The pressure of the population on the land is reflected in the human problems of the area, such as the very slow repayment of the emergency crop loans made here, the unusually heavy relief loads for strictly rural counties, and the large amount of state aid annually needed by the schools.

(Exhibit.)

GRIFFITH TAYLOR.

Sea to Sahara: Zones of Settlement in East Algeria.

An account of a traverse of 300 miles from Philippeville on the coast (with forty inches of rain) to Touggourt which lies 170 miles south of the desert edge. Studies were made of a dozen settlements to show how diminution of the rainfall affects human conditions. The sharp change from a wheat culture to a date culture at El Kantara is of great geographical interest. The presence of regular vegetation and absence of dunes was somewhat unexpected. The character of the Artesian Basin of Oued Righ is described.

LEWIS F. THOMAS.

Life Cycle of the Post of St. Louis.

It is customary to look to lands which have a long ancient history for cities which have completed their life history. It may be somewhat of a surprise, therefore, to note that in the heart of one of our larger American cities the original town attained successful maturity, declined slowly to an old age culminating in death. I refer to the Post of St. Louis, Missouri, which was founded in 1764, enjoyed its golden age in the 70's, and now is to be cleared. In its place will arise a national memorial to Western expansion. I propose to point out in my paper the factors which led to its successful rise, to its prosperous years, and to its final decay.

The headings include, "The Fur Trade," "Western Immigration and Settlement," "The Steamboat Services," "The Railway Net," "The Shift in the Business Center of St. Louis," "The Effects of Absentee Ownership," "The Circumstances Surrounding its End," and "The Proposals for its Memorialization."

Also I wish to suggest how a different line of development two decades ago would have postponed indefinitely its present abandonment.

EDWARD N. TORBERT. (Introduced by G. Donald Hudson.)

Utilization of Findings in the Appraisal of Projects and the Planning of Readjustments.

Paper No. 5 of a series of seven relating to river development in the Knoxville-Chattanooga area.

The Land Planning Division of the Tennessee Valley Authority conducts two different types of reservoir studies designed to help answer different questions which arise at two stages in a dam-construction program.

The first type of study, illustrated by an investigation of the Watts Bar Project, precedes final decisions on engineering specifications and aids in the decision as to which of several possible developmental plans is most desirable. The study is concerned with the appraisal of the relative economic and social effects of the alternative plans. Comparisons are first made from the standpoint of changes in the cultural and physical environment which each plan would cause. There follows an analysis and comparison of the probable effects of these changes upon each of three units affected: the region, local governments, and local retail trade units.

The second type of study, illustrated by an investigation of the Chickamauga Project, follows decisions on engineering specifications and is designed to help in pointing out the best practicable readjustment to the changed cultural and physical environment which will follow completion of the dam and impoundage of the lake. Analysis of the probable effects upon the region and upon local economic and social units reveals the extent and character of the readjustment problem. The investigation of possible lines for readjustment involves consideration of the major economic activities of the region and the resources upon which they depend, trends in these activities, and specific potentialities for new types of development centering in utilization of the lake created.

SAMUEL VAN VALKENBURG.

Cycle in the Development of Nations.

It is possible to recognize four stages in the sequence of development of nations, namely youth, adolescence, maturity and old age. This cycle can be interrupted any time and brought back to a former stage of development. The time element (duration of one of the stages) depends on the geographical conditions within and outside the nation. During youth a nation is primarily interested in its own affairs: to put its house in order. During adolescence it will try by expansion to increase its standing among the nations of the world; it will be dynamic and a danger to world peace. During

the maturity that desire has disappeared; the nation is still energetic enough to defend itself against attack but wants to be left alone; it becomes a defensive power rather than an offensive one. Finally in old age even the strength for defense has weakened. Disintegration from within and attack from the outside will cause the collapse of the nation which will either disappear completely or arise once again to start a new cycle.

HAROLD B. WARD. (Introduced by W. H. Haas.)

Coffee vs. Sugar in Puerto Rico.

Although Puerto Rico can produce an excellent high grade coffee similar to Arabian coffee, there is a growing tendency to change the coffee plantations into sugar producing areas. The reasons for this change are many, but the problem of whether the economic status of the people will be improved is not so easily solved. This paper deals with the conditions that have brought about the change, the magnitude of the change, and the problems faced by the Puerto Rican farmer.

JOHN C. WEAVER. (Introduced by V. C. Finch.)

Silver Peak and Blair; Two Types of Desert Mining Communities.

Within the borders of the Clayton Valley, a typical bolson in the desert of southwestern Nevada, the opportunity was afforded to observe the genesis and development of two distinct types of settlement. Though the human element makes itself manifest in this area on a very limited scale, the cultural dynamics which are operative here are none the less fundamental. The settlements which are briefly compared in this study represent two settlement forms which are commonly found in saxicultural regions.

The first of these two communities to be established was the village of Silver Peak. This small mining camp came into existence in 1863 with the discovery of the Vanderbilt silver veins in Silver Peak Mountain, less than two miles to the west of the site chosen for the camp at the eastern base of the range. The water which issues from the springs at this point, affording the only potable water for many miles around, made this the most suitable site for the town. Though never a large or important settlement, this village has, with a population ranging between 100 and 140 persons, maintained, through seventy-five years, a continued existence to the present.

The second mining camp to appear in this region, Blair, came into existence suddenly with the active entrance into the region of the Pittsburg-Silver Peak Gold Mining Company in 1907. This settlement was situated at the head of an alluvial fan three miles north of Silver Peak. Within three months it had a population of 500 people and one of the greatest low grade ore processing mills ever built in Nevada.

However in 1915, when the Pittsburg-Silver Peak Gold Mining Company ceased operations, Blair disappeared as quickly as it had grown up. Every movable piece of mill and mine equipment, every board of every building in town, in fact every movable item of the smallest value was placed on the company-built railway and transported out of the region. With that done, the rails and even the ties of the railway were taken up and almost every vestige of this one-time thriving community had disappeared.

Thus Blair and Silver Peak furnish an interesting contrast between two types of desert mining camps. Silver Peak is, essentially a *native town*, whereas Blair was a *foreign town*. That is, Silver Peak was founded by, and has served more or less permanent settlers in this desert country. Blair, on the other hand, was brought into existence by, and served the whim of corporate interests from outside the region. The ultimate contribution of these two types of towns to the areal scene is clearly demonstrated in the Clayton Valley.

RAYMOND H. WHEELER. (Introduced by Ellsworth Huntington.)

History Cycles and Climate.

Following the work of Huntington and others an elaborate analysis is in progress, of the relationships between cultural evolution, or culture trends, and climatic changes. Human behavior throughout history is being studied in terms of some two hundred fifty or more specific behavior variables. These variables constitute integrated culture patterns to such an extent that, knowing one of the variables, the others can be predicted. During warm periods, the culture pattern, as statistically determined by the distribution of these variables, is classical, aristocratic, organic, and totalitarian. As warm periods shift to cold, the culture pattern shifts to its opposite and becomes romantic, democratic, atomistic, proletarian, and individualistic. More specific among the warm-climate variables are rationalism, deduction, idealism, abstract art, socialistic views, cooperation theories of biology and science, evolution, vitalism, teleology, geometry, and epigenesis. Among the cold-climate variables are empiricism, induction, utilitarianism, laissez-faire, anatomy, preformation, algebra, competition theories of biological and social evolution, concrete and imitative art. Measures have been obtained of the objectivity of estimates regarding the predominance of these variables at different times.

Human behavior is integrated with environment to the extent that both follow a pendulum principle, with minimum kinetic energy at the maxima of the cycles and maximum kinetic energy during transition times, that is, at the axis. There pile up at the axis, wars, revolutions, storminess, vol-

canic action, earthquakes, and rainfall maxima. It is at the axis also that the sun-spot cycle radically changes in length, becoming longer with lower numbers at the onset of a warm period, shorter and with higher numbers at the onset of a cold period. Wars decrease, the birth rate decreases, and economic recessions occur at the maxima of the cycles. On the one side the maximum is hot and dry, on the other, cold and dry. The first part of the warm epoch especially near the axis, is warm and wet; the second part, until the axis is reached again, is dry. The first part of the cold epoch, especially near the axis, is wet; the second part, dry. Temperature recovers ahead of rainfall so that as a rule a climate cycle consists of the following phases of varying length: cold-dry, warm-dry, warm-wet, warm-dry, cold-wet, then cold-dry again. A method has been worked out which seems to be tolerably accurate, of deducing climate from tree growth. These deductions check very well with temperature and rainfall curves of the last one hundred years, with lake levels, and a great variety of incidental information. All of Clayton's "World Weather Records" have been analyzed and summated with the conclusion that there is an approximation to a world climate.

DERWENT WHITTLESEY.

Regional Patterns in Contemporary Boston.

A series of slides showing correspondence between certain cultural and natural patterns in the area of uninterruptedly built-up city which has grown from the settlement on Boston Head in 1630—an area closely corresponding today to the geological "Boston Basin."

Items of the natural pattern shown include the outline of the Boston Basin, with its eastern portion partially drowned; fault line scarps, intrusions, and wet lands—features that have debarred, delayed, or deflected settlement; zones of water power. Cultural features: the outline of uninterrupted urban settlement; commercial cores within and immediately outside this line; ways—water, rail, and motor; made land; factory zones; reservations for recreation and water supply; the Boston municipal boundary.

Conclusion.—Patterns of occupancy in the Boston conurbation have continuously adapted themselves to conditions imposed by nature. At the same time some natural conditions have been grossly modified. Perhaps no other major American city so neatly displays this eternal geographic seesaw.

LEONARD S. WILSON. (Introduced by Laurence M. Gould.)

The Settlement of Minnesota.

In a study presented last year dealing with the Faribault unit of settle-

ment three distinct periods of occupancy were observed in the state of Minnesota. Further research indicated the same number of eras of occupancy for the state as a whole. From 1838 to 1857 the chief interests of the population were pioneer in character. Subsistence farming combined with trapping and lumbering was the mode of existence. This was followed by the wheat era which was first well developed in 1860. Associated with this grain, but of much less importance, oats and corn combined to complete the important field crops. This period of settlement terminated in 1890 but its effect was prolonged by factors arising outside of the state. These were depreciation of the currency, the panic of 1880, and unfavorable wheat weather which characterized the more settled parts of the country.

By 1910 the wheat market had declined and a more generalized type of dairy farming had succeeded grain farming. This has continued until the present.

Accompanying the historical development of population and agriculture, several relationships existed between the age of settlement and the crops produced. Wheat has remained the major frontier crop while the more established parts of Minnesota changed to a combination of corn and dairy production. Minnesota's position in wheat production has resulted from planting in new, unsettled parts of the state rather than by a continued concentration in a given section. Wheat has been followed in all areas by a diversion to corn and dairy economy.

Apparently there is a relationship between the course of settlement and the three zones of natural vegetation. The nuclear point of attachment was in the zone of contact between the coniferous forests of the northeast, the Big Woods, and the prairies. From this point settlement spread westward, avoiding the coniferous stands, but following the major rivers. This pattern of coincidence may be noted in every period from 1850 to 1930.

Only within recent years has settlement been attempted in the cut-over lands. Nearly all of this is associated with the iron deposits. None of these settlers have displayed any interest in the agricultural possibilities of their environment.

At the present time the pattern of distribution of the inhabitants, and their associated dominant crops, follows the initial pattern of settlement observed in 1850. It appears probable that the state of Minnesota is entering the climax stage of settlement. Any changes in pattern or economy will be of a minor character, and a mere filling-in of the outlines clearly discernible today.

(Exhibit.)

Exhibits at the Cambridge Meeting

Displays illustrating papers and graphic expositions not correlated with the sessions have become an integral part of the annual meetings of the Association. The exhibits at Cambridge accented physical geography rather more and human geography rather less than has been the case in recent preceding years. In a number of cases comparable maps of physical and human phenomena were displayed side by side. This appears to indicate a pronounced interest in regional correspondence of phenomena.

Meteorology and climatology were well represented. Charles F. Brooks showed photographs and maps of meteorological stations—Blue Hill, Mt. Washington, and Novaya Zemlya. Also photographs depicting ice columns as erosive agents. He hung 26 climatic maps of North America prepared for the Koeppen-Geiger *Handbuch der Klimatologie*. H. E. Willett posted a set of maps illustrating extreme conditions of weather in New England: a hot wave, a northeast snowstorm, and the hurricane of September 21, 1938. R. G. Stone displayed snow and rain maps of New York State and new England, together with seven climograms. A new map of the climates of North America, according to the Koeppen system, was shown by E. A. Ackerman.

A large exhibit of the United States Soil Conservation Service comprised copies of its voluminous published work, including the published atlas of the Erosion Survey of the United States. About 30 pamphlets were available for distribution. Some of their less bulky meteorological instruments were exhibited, along with photographs showing them in operation. There were also pictures of instruments for measuring soil erosion, including the lysimeter. Maps and graphs depicted the results of the highly detailed and frequent observations of weather and erosion being conducted by the Service. Manuscript papers on land-use aspects of watershed studies by C. E. Ramser were available for perusal.

A large number of exhibits portrayed surface configuration, either with or without correlative maps of other phenomena.

The Rio Grande Valley of New Mexico was covered by nine relief maps, and the Santo Domingo Valley by three on a much larger scale, together with geological sections—all these being results of recent field studies by Kirk Bryan. George B. Cressey showed five maps of landforms in Chekiang, China, two of which were published on a reduced scale in the December, 1938, *Annals*.

Preston E. James presented in behalf of their author, R. Maack, two maps of Paraná State, Brazil, covering its geology and its natural vegeta-

tion. Ten maps of the Ozarks by A. B. Cozzens showed surface configuration and cover, together with natural regions based thereon.

H. Thompson Straw hung eleven type-study maps of an area in Tennessee, dealing with geology, landforms, and crops. Leonard S. Wilson displayed an equal number of maps of Minnesota. Three of them showed surface configuration and cover; eight dot maps portrayed population at intervals during the period of settlement and wheat production for the same years. Three aerial mosaics and a land-use map of Delta County, Michigan, by J. A. Russell were accompanied by detailed explanations of salient items represented on the photographs, a device very helpful in the interpretation of aerial mosaics. W. A. Bagley showed a stereo-map-plotting instrument designed to expedite the preparation of topographic maps from aerial photographs.

Several exhibits concerned themselves exclusively with distribution of phenomena of human origin.

A map of Liberia, prepared by Erwin Raisz, from data furnished by G. W. Harley, presents many details of place geography heretofore unmapped. W. A. Applebaum hung a detailed map of Cambridge, portraying functional areas and population densities by blocks. William B. Brierly had a series of dot maps showing the distribution of certain epidemic diseases in the United States, both by cases and by resultant deaths. Harry Todsal hung a published map dividing the United States into sixty trading areas, and showing also the basic trading areas (subdivisions of the major areas). Eight maps and seven photographs of the United States-Canada boundary were displayed by S. Whittemore Boggs. H. R. Friis hung a series portraying the advance of settlement in North America from colonial times to the close of the westward movement.

The temporary displays were installed in the Institute of Geographical Exploration without disturbance to the permanent exhibits housed there. Several of these attracted attention and comment, particularly a memorial to the late William Morris Davis. This consists of his published books and reprints, and a number of manuscript notebooks and photographs—mostly concerned with the physiography of the United States.

For the convenience of those in attendance Erwin Raisz prepared a map of Downtown Boston and the Harvard Square District of Cambridge. It picked out the buildings in which meetings were held and the routes between them. In addition it located functional areas likely to interest visitors with a geographic turn of mind. A detailed map of Harvard College, also the work of Dr. Raisz, was likewise available.

